MASSACHUSETTS

WATER CONSERVATION STANDARDS

~~*The Commonwealth of Massachusetts*~~
~~**EXECUTIVE OFFICE of ENERGY AND ENVIRONMENTAL AFFAIRS**~~
~~and~~
~~**WATER RESOURCES COMMISSION**~~
~~**July 2006**~~
~~**Updated June 2012**~~

~~**Note on**~~

The Commonwealth of Massachusetts

EXECUTIVE OFFICE of ENERGY AND ENVIRONMENTAL AFFAIRS

and

WATER RESOURCES COMMISSION

February 2018 [DRAFT]

Letter from the ~~2012 Update of the MASSACHUSETTS Water Conservation Standards June 2012~~

~~The Massachusetts Water Resources Commission completed a major revision and update of the Massachusetts Water Conservation Standards in July 2006. It is the intent of the commission to review the standards every five years and update them as needed.~~

~~A substantive review of the 2006 standards is in progress. Until this review is completed, nonsubstantive revisions and updates to the information in the 2006 standards have been incorporated into this edition.~~

~~This document is available on the web site of the Massachusetts Water Resources Commission.~~

June 2012

DEAR WATER USER,

It is with great pleasure that I present to you the Massachusetts Water Conservation Standards.

Massachusetts is rich with many water bodies and plentiful rainfall. But as our demand for water increases with growth, and our infrastructure ages, some of our streams and lakes have become stressed and we are facing water supply shortages. Today, the need to use our water efficiently with minimal amount of waste is critical to the long-term health and viability of these important resources.

Massachusetts first published water conservation guidelines in 1987. Since then, technological advancements have greatly helped improve the efficiency of water use. Additionally, our understanding of the impacts of human water use on the natural environment has increased. The current Water Conservation Standards continue to establish updated statewide goals for water conservation and water-use efficiency and provide guidance on the most current conservation measures. They will help bring greater awareness among users about water use and water waste, help tighten our infrastructure, ensure sustained water supply, and move us forward toward more pragmatic water use.

The Water Conservation Standards will be an invaluable resource for all citizens, businesses, and governmental bodies in the Commonwealth.

Sincerely,

Richard K. Sullivan, Jr.

Secretary

TABLE OF CONTENTS

ABBREVIATIONS

ASR	Annual Statistical Report
AWWA	American Water Works Association
CMR	Code of Massachusetts Regulations
~~DAR~~	~~Department of Agricultural Resources (Massachusetts)~~
~~DCR~~	~~Department of Conservation and Recreation (Massachusetts)~~
~~DFG~~	~~Department of Fish and Game (Massachusetts)~~
~~DHCD~~	~~Department of Housing and Community Development (Massachusetts)~~
EEA	Energy and Environmental Affairs, Executive Office of (Massachusetts)
EPA	Environmental Protection Agency (U.S.)
gpcd	Gallons per capita per day
gpd	Gallons per day
gpf	Gallons per flush
gpm	Gallons per minute
HET	High-efficiency toilet
ICI	Industrial, commercial, institutional
I/I	Infiltration and Inflow
IWRMP	Integrated Water ~~Resource~~Resources Management Plan
LID	Low-impact development
MaP	Maximum performance testing
MAPC	Metropolitan Area Planning Council
MassDEP	Massachusetts Department of Environmental Protection
MEPA	Massachusetts Environmental Policy Act
MGL	Massachusetts General Laws
MWRA	Massachusetts Water Resources Authority
NEWWA	New England Water Works Association
NPDES	National Pollutant Discharge Elimination System
OTA	Office of Technical Assistance (Massachusetts)
psi	pounds per square inch
REUWS	Residential End Uses of Water Study
RGPCD	Residential gallons per capita per day
~~SDI~~	~~Subsurface drip irrigation~~
UAW	Unaccounted-for water
UMass	University of Massachusetts
WRC	Water Resources Commission (Massachusetts)

Acknowledgements

The Executive Office of Energy and Environmental Affairs (EEA) and the Water Resources Commission ~~were assisted by a workingsincerely appreciate the efforts of the many work~~ group ~~of representatives of various interests and expertise that provided technical, policy, and regulatory advice during development of the 2006~~participants who met for over a year to guide the 2018 update of the Water Conservation Standards. ~~While the Standards do not reflect the opinions of every participant, EEA would like to acknowledge the members, as well as their~~We thank you and your respective organizations, for ~~their~~your time and invaluable input.

~~For the 2006 update of this document, the Water Conservation Standards Work Group comprised the following membership:~~

~~Gerard Kennedy Department of Agricultural Resources~~
~~Michele Drury Department of Conservation and Recreation~~
~~Mike Gildesgame Department of Conservation and Recreation~~
~~Anne Monnelly Department of Conservation and Recreation~~
~~Jonathan Yeo Department of Conservation and Recreation~~
~~Duane Levangie~~Rich Bradley, Superscape Landscape
Wayne Castonguay, Ipswich River Watershed Association
Alan Cathcart, Concord Water and Sewer
Shi Chen, MA Department of Environmental Protection
~~George Zoto~~Eileen Commane, Dedham Westwood Water District
Catherine DeRonde, MA Department of Agricultural Resources
Jen D'Urso, MA Department of Environmental Protection
~~Mike Hanlon Environmental Business Council~~
~~Dan Moon Environmental Business Council~~
~~Karl Honkonen Executive Office of Environmental Affairs (formerly with EOEA)~~
~~Kathy Baskin Executive Office of Environmental Affairs~~
~~Vandana Rao Executive Office of Environmental Affairs~~
~~Lou Wagner~~Dr. J. Scott Ebdon, University of Massachusetts ~~Audubon Society~~
~~Roger Brooks Massachusetts Clean Water Council~~
~~Pam Heidel~~Stephen Estes-Smargiassi, Massachusetts Water Resources Authority
~~Raymond Jack Massachusetts~~Richard Friend, MA Department of Environmental Protection
Colleen Heath, CDM Smith
Eric Hooper, Sharon Department of Public Works
Nancy Hammett, The Hammett Group
Dr. Rob Johnston, Clark University
Duane LeVangie, MA Department of Environmental Protection
Christine Millhouse, Attleboro Water ~~Works Association~~Department

~~Phillip Guerin Massachusetts~~Matt Mostoller, Acton Water ~~Works~~District
Mary Owen, University of Massachusetts
Laila Parker, MA Department of Fish and Game
Leah Stanton, Weston and Sampson
Chris Woodcock, Woodcock Associates
Samantha Woods, North and South Rivers Watershed Association

~~In addition, we would also like to express our appreciation to the public for providing detailed comments in writing and at the public meetings. Finally, we would like to especially acknowledge the following entities for their expert input – Amy Vickers (Amy Vickers and Associates, Inc.), Pat Rogers (MassDEP), Paul Lauenstein (Neponset River Watershed Association Board), Irrigation Association of New England, Massachusetts Instream Flow Task Force, Mary Owen (UMass Extension), Massachusetts Municipal Association, Gus Ogunbameru (Office of Technical Assistance), Russ McIntosh (Sebesta Blomberg & Associates, Inc), and the Water Supply Citizens Advisory Committee.~~

We would also like to thank the following staff for all their efforts: Marilyn McCrory, Erin Graham, Sara Cohen, and Anne Carroll from the Department of Conservation and Recreation, and; Kathy Baskin (formerly at EEA) and Vandana Rao from EEA.

Introduction to the Water Conservation Standards

Intent and Purpose ~~of the Water Conservation Standards~~

The *Water Conservation Standards* (the Standards) set statewide goals for water conservation and water ~~-~~use efficiency~~,~~ and provide guidance on effective conservation measures ~~to meet the statewide goals identified in the 2004 Massachusetts Water Policy[1] (Water Policy).~~ The Standards also provide a vehicle to educate Massachusetts' citizens about the importance of water conservation, its crucial link to our natural resources, and how all consumers can use water more efficiently. Water conservation is defined as any beneficial reduction in water loss, waste, or use, and water efficiency is defined as the accomplishment of a function, task, process, or result with the minimal amount of water feasible ~~(Vickers 2001). In this document, the terms~~[2]. As short-term droughts are predicted to occur more frequently in coming years due to climate change, water conservation and ~~water~~ efficiency ~~are used interchangeably~~continue to become ever more critical tools for the Commonwealth's long-term sustainability.

This document includes both *standards* and *recommendations*. *Standards* ~~and *Recommendations*. *Standards are achievable, implementable, and practical measures*~~ represent best practices. They should be adopted by water suppliers~~, small~~ and ~~large~~ water users, ~~and~~as applicable, wherever possible. They should also be incorporated by state agencies ~~in carrying out their~~into water resources ~~planning and~~ management programs and ~~in issuing~~the issuance of permits or approvals that ~~involve~~govern water use. ~~The Massachusetts Executive Office of Energy and Environmental Affairs (EEA) strongly encourages and supports the adoption of *Recommendations* wherever possible.~~ *Recommendations* represent emerging thinking in water-use efficiency. Although they may not currently be suited to a regulatory context or may not be as widely achievable~~, implementable, and practical at~~ in the ~~present time~~short term as standards due to economic or technical ~~reasons, they indicate~~limitations, the ~~trend in responsible water use and may serve as a starting point for examining standards in future revisions of this document.~~

~~Background~~

~~These~~ Massachusetts Water ~~Conservation~~Resources Commission strongly encourages their adoption wherever possible. Together, the standards and recommendations should guide all programs affecting the planning and management of the Commonwealth's water resources, including but not limited to: local and state water conservation plans, the Water Management Act, the Interbasin Transfer Act, and the Massachusetts Environmental Policy Act (MEPA). They should also be incorporated into construction, rehabilitation, operation, and facility development activities statewide, as applicable.

The Standards are intended as a foundation, helping to establish baseline efficiencies across sectors. In times of drought and water supply shortage, the Commission strongly urges communities and agencies alike to go beyond the practices outlined herein whenever possible.

History

The Standards issued here are ~~a~~another revision of the original Water Conservation Standards, adopted by the Water Resources Commission (~~WRC~~the Commission) on ~~July 13, 2006, and~~ October 13, 1992. The ~~goal of the~~ 1992 Standards ~~was to develop policies and specific recommendations~~were intended to assist ~~Massachusetts~~Massachusetts' public water suppliers in achieving ~~the maximum possible water~~ efficiency in their

[1] ~~Massachusetts Water Policy (2004)~~

[2] Vickers, Amy. 2001. *Handbook of water use and conservation.* Amherst, MA: WaterPlow Press.

~~public water supply~~ systems and to ~~educate end users, homes, factories, and other~~ foster education of residents, industrial facilities, and places of business on ~~conservation measures.~~

~~The 1992 Standards emphasized educating water suppliers and consumers on the~~ the importance of ~~system efficiencies~~water efficiency and effective conservation~~. The 1992 Standards focused on the development of local water conservation and resource management plans led by local conservation officials. A key approach was to charge the full cost of water to consumers and develop enterprise accounts. Subsequently, the Water Management Act program at the~~ measures. The Massachusetts Department of Environmental Protection (MassDEP) used the 1992 Standards to condition water withdrawal permits under the Water Management Act program, and the ~~WRC~~Commission used the Standards in reviewing ~~interbasin transfer~~ applications~~. The 1992 Standards were also fundamental to~~ under the ~~2001~~ Interbasin Transfer Act ~~Performance Standards and have served as a benchmark for reviewing conservation efforts statewide.~~.

~~The statewide Water Policy developed by EEA in 2004 identified the revision of the Standards as a crucial step in moving forward with water resources planning to sustain the economic and environmental value of our water resources. Water conservation is an essential component of a comprehensive effort to ensure that there will be sufficient water available now and in the future to meet the needs of humans as well as natural communities.~~

~~The 2006 update entailed a comprehensive review and substantive revision of the 1992 Standards. The 2006 Standards emphasized that "there is a role for everyone" in using water efficiently.~~In July 2006, the Commission completed a major revision and update of the Standards. New sections addressed comprehensive planning, water audits, and agricultural water use, and key features of the Lawn and Landscape Addendum to the 1992 Standards were incorporated. ~~Standards~~ Numeric standards for residential water consumption (65 gallons per capita per day) and unaccounted-for water (10 percent) were also added. ~~The Water Resources Commission adopted~~ In 2012, the ~~revised~~ Standards ~~in July 2006, with the intent that~~underwent minor non-substantive revisions such as changes to website addresses and agency names to ensure the citations, resources, and governmental entities listed were current. This edition represents substantive changes to the 2012 Standards ~~be reviewed~~. It is the intent of the Commission to review the standards every five years and ~~updated~~update them as needed.

~~Introduction~~

~~Massachusetts has been a leader in the field of water resources protection, including water conservation and efficiency. On an average annual basis, Massachusetts has one of the lowest per capita residential demands in the country. The state is home to the Massachusetts Water Resources Authority (MWRA), which in the 1980s developed a highly successful water conservation program that resulted in dramatic reductions in its water supply system demand. Those gains have been sustained to this day. Many communities outside the MWRA distribution system have also made investments in water conservation and efficiency that have resulted in reductions in per capita demand and water supply system efficiency.~~

~~Despite these improvements, significant opportunity exists for greater water use efficiency that will generate economic, public health, and environmental benefits. Many water suppliers are finding it increasingly difficult to meet essential public water supply needs for drinking, bathing, cooking, and fire protection. Although water use on a per capita basis varies widely from community to community and also from season to season, data show that great opportunity remains for improved efficiency in water systems and water use by consumers.~~

~~*Massachusetts'*~~ *Background and Goals*

Massachusetts's economy~~ is~~, environment, and quality of life are inextricably linked to its ~~natural~~water resources~~, water being a critical one~~. The Commonwealth receives an average of ~~45~~49 inches of rainfall each year~~ – an amount many consider to be plentiful compared to other areas of the country. However,~~[3], although rainfall ~~varies~~can vary significantly from year to year ~~and can drop to below 30 inches~~ during a severe drought year~~. Short~~, precipitation can drop to below 30 inches. Because Massachusetts's geology features relatively shallow aquifers (natural underground storage capacity) in most regions, even short-term droughts can ~~severely~~ deplete water ~~supplies as well as source rivers~~supply sources, streams, and ponds. ~~Also, weather patterns are seasonal, and in summer, when evapotranspiration goes up, there is typically less rainfall available to contribute to recharge. It is also important to recognize that Massachusetts is one of the most densely populated states in the nation with~~With over six million people living on slightly more than six million acres of land~~.~~, annual typical seasonal use patterns can also lead to shortages, as high summertime demand coincides with the period of highest water uptake by forests and other vegetated landscapes. In fact, ~~the per capita water availability is significantly less than some desert states, such as Nevada. Hence, Massachusetts' current water use and future growth and development need to work within these constraints.~~

~~Furthermore, the Commonwealth's native flora and fauna rely upon the relative abundance of water in our natural environment. Our native aquatic and riverine organisms show a considerable degree of resiliency, surviving naturally occurring low flow periods that result from extended periods without precipitation. However, human activities (such as streamflow depleting water withdrawals, especially during natural low-flow periods, and increases in impervious surfaces) can increase the duration, frequency, and/or severity of low flow conditions beyond natural levels. Placing streams under chronic unnatural low flow conditions can cause substantial harm to aquatic and other water dependent organisms and habitats, and ultimately to our economy and quality of life through loss of scenic, recreation, and property values. It can also result in a loss of other less obvious but vital ecosystem services such as purification of our water and reproduction of economically valuable marine species.~~

~~Massachusetts, therefore, continues to have an obligation to emphasize water use efficiency in order to:~~

~~1. Preserve the Commonwealth's water resources, as part of the public trust;~~

[3] National Weather Service, 30-year average (1981-2010)

~~2. Sustain water supplies to meet current and future needs;~~

~~3. Protect aquatic ecosystems and minimize water supply impacts; and,~~

~~4. Provide financial savings in the cost of water.~~

1. Preserve the Commonwealth's Water Resources as Part of the Public Trust

The WRC has outlined the State's interest in protecting water resources as public resources to be held in trust for current and future generations, as follows:

> "Water is a valuable resource of the Commonwealth, and as such, the state needs to establish laws and policies to provide for its multiple uses, protect its quality and ensure that it is available to meet the legitimate needs of its citizens. The state's overall goal is to ensure that water is available in sufficient quantity and quality to meet Massachusetts' current and future needs and to accommodate both consumptive and non-consumptive needs." (WRC 1984)

Water resources science and policy have evolved considerably since 1984 and today there is an increased emphasis on demand management as an essential component of the effort to ensure the sustainability of our water resources.

2. Sustain Water Supplies to Meet Current and Future Needs

Although Massachusetts receives relatively despite abundant rainfall and has numerous rivers, lakes and ponds, many cities and towns have found themselves facing, some of the Commonwealth's water shortages. Water suppliers increasingly find new source development difficult due to a variety of have difficulty meeting demands, between stresses on existing sources and constraints on new sources including cost, time, environmental impacts, regulatory requirements, and an increasing scarcity of suitable sites. Finding new water by investing in efficiency and demand management is almost always more cost-effective than developing a new source.[4] Demand or system management through programs such as leak detection, metering, conservation pricing, and reductions in indoor and outdoor use, has the additional benefit of causing no environmental impacts, unlike developing new water sources. Water savings that result from increased efficiency can, in effect, serve as a new water source. Efficiency should be given priority over new source development, with the understanding that in some cases new water supply sources will be needed to accommodate new growth and/or to offset localized environmental stress or other factors.

3. Protect Aquatic Ecosystems and Minimize Water Supply Impacts

In addition to meeting the growing demand for water for human use and consumption, instream water-dependent uses must also be protected. Instream uses include aquatic habitat for wildlife, flow, temperature-dependent fisheries such as brook trout, and water-dependent recreation such as paddling, fishing, and swimming. Some areas of Massachusetts are experiencing environmental impacts, related in part to drinking water withdrawals and movement of wastewater to another basin, including deterioration of water quality, loss of stream flow, loss of habitat, and disruption of connection between habitats.[5] Water taken from aquatic systems for public water supply is only one component of the water balance. However, it can be a substantial component, especially if the greatest water demands are occurring during the summer season, or during extended droughts, when water is least available in the natural environment. Dams, diversions, and export of wastewater from our river basins can also place significant stress on aquatic ecosystems and alter the streamflow and hydrology in our watersheds. Water savings that result from increased efficiency can help protect aquatic habitat, mitigate the impact of withdrawals, and restore balance to the stressed natural systems.

---

[4] That said, it is possible for a new water supply source to have a net environmental benefit if it replaces or mitigates an existing source that causes adverse ecological impacts (such as eliminating or reducing pumping from an existing shallow streamside well that desiccates an adjacent stream).

[5] For examples of observations of streams with unnaturally low- or no-flow conditions please see the Riverways' Low Flow Inventory at: http://www.mass.gov/dfwele/der/riverways/programs/ri-fls/lowflow-inventory.htm

~~4. Provide Financial Savings in the Cost of Water~~

~~Increasing water-use efficiency can provide an economically competitive advantage for public water suppliers and businesses by reducing operating and maintenance costs (lower electrical power costs and reduced chemical costs for water treatment), reducing wastewater treatment costs, freeing up plant capacity for pumping and treatment of water and wastewater, and avoiding the considerable cost of investing in new sources of water. Individual residents, businesses, and the public sector save significantly by decreasing their water use. Water conservation can significantly improve the performance and longevity of septic systems, benefiting the users of such systems as well as the integrity of adjacent surface and ground waters. Greater water efficiency can also delay, avoid, and restrain capital costs to develop, treat, and convey additional water, and reduce needed wastewater treatment capacity.~~

~~Summary~~

~~Water-use efficiency is~~

The Commonwealth's native plants and animals have evolved to depend on the water in our natural environment. Low stream flows and water body levels can decrease water quality, cause loss of habitat, and disrupt connections between habitats. Our ecosystems are quite resilient in the face of naturally occurring periods of drought, but human water withdrawals can magnify the duration, frequency, and severity of low water conditions beyond natural levels. Climate change is also expected to increase the frequency and severity of drought in Massachusetts. Rainfall patterns also appear to be shifting toward more total annual precipitation but concentrated into fewer, more intense storms, which leads to more rapid runoff and less retention of rainfall in the groundwater and stream systems[6]. Placing streams and wetlands under chronic and unnatural low-flow conditions can cause substantial harm to aquatic organisms and ecosystems, and ultimately to our economy and quality of life through loss of scenic and recreation value, loss of ecosystem services such as pollution mitigation, and loss of economically valuable species.

In short, stresses on Massachusetts water resources are felt by both our communities and our natural ecosystems. Massachusetts' water use and growth and development need to respond to these constraints. While Massachusetts has achieved great strides in water conservation and water efficiency, achieving one of the lowest residential per capita water demands in the country, significant opportunities remain for even greater improvements. By continuing to help Massachusetts make strides in water conservation and efficiency, the Standards are intended to:

1. Preserve water resources as the Commonwealth's public trust;

2. Sustain water supplies for current and future needs, including in times of drought;

3. Reduce negative impacts on aquatic ecosystems;

4. Reduce utility costs by:
    a) reducing water waste and associated energy and treatment costs;
    b) prolonging the natural life of system components and equipment; and
    c) postponing or eliminating the need to develop additional water supply sources;

5. Spur economic development by helping ensure reliable and sustainable access to water.

[6] National Weather Service, "Climate Change in Massachusetts and its Impact on River Flood Behavior" (presentation to the MA Water Resources Commission, October 2017)

Thinking Long-Term

Water conservation and efficiency are critical to ensuring the long-term sustainability of water supplies and ~~in balancing consumptive and instream uses. Water use efficiency is becoming increasingly important as water demand rises. It is a crucial factor in sustaining the economic health of the State and continued vitality of the region. Its great~~the abundant ecosystems that rely on water in the natural environment. Their promise ~~resides~~lies in the idea that increasing knowledge, sophistication, technology and care can save substantial volumes of water and increase the productivity of each unit of water that is used. In turn, such an environmentally responsible approach to the use and management of water resources is a crucial factor in sustaining the economic health and continued vitality of the State, as well as its preparedness and resilience in the face of drought.

~~Implementation of the Water Conservation Standards~~

~~The standards and recommendations should be used in all programs affecting the planning and management of the Commonwealth's water resources, including the Water Management Act, the Interbasin Transfer Act, and the Massachusetts Environmental Policy Act (MEPA). Water conservation standards should also be included in all construction, rehabilitation, and facility development activities statewide.~~

~~The standards and recommendations outlined in this document reflect the most current technical and operational knowledge about water-use efficiency.~~

Overview of the Standards and Recommendations

There is a role for everyone in water conservation and efficiency efforts. Each segment of the water-using community ~~must do its part to understand and~~ can support the ~~need for~~ collective effort to reduce water ~~conservation~~waste and ~~encourage~~use water~~-saving practices on an individual and community level.~~ more efficiently for essential purposes. The ~~following~~ standards and recommendations in this document are intended for adoption~~ statewide~~, as applicable, by ~~all~~: government entities and regulating bodies; municipal, private, and regional water suppliers; and ~~users~~water consumers, including individual ~~consumers~~households, businesses, industries, and public agencies.

The ~~standards and recommendations cover~~Standards are organized into ten chapters, addressing key areas of water supply planning ~~and~~, management, and ~~indoor and outdoor water~~ use~~, including the following ten topics~~:

1. Comprehensive Planning and Drought Management Planning
2. Water ~~Audits and Leak Detection~~Loss Control
3. Metering
4. Pricing
5. Residential Water Use
6. Public Sector ~~Use~~
7. Industrial, Commercial, and Institutional ~~Use~~
8. Agricultural Water Use
9. Outdoor Water Use
10. ~~Lawn and Landscape~~
11. ~~11.~~10. Public Education and Outreach

~~The goals of the standards and recommendations are to:~~

1. ~~Integrate water conservation and efficiency measures into all aspects of water supply planning and management;~~
2. ~~Maximize the efficiency of public water supply system operations by conducting regular water audits, performing regular leak detection as recommended through audits, promptly repairing leaks, metering all users of water supply systems, and practicing full-cost pricing;~~
3. ~~Reduce indoor/outdoor water use by setting efficiency standards that are specific and measurable, and recommending options to meet or exceed those standards;~~
4. ~~Emphasize and implement water conservation in government buildings and facilities to accurately account for water use and to demonstrate water-saving techniques and concepts to the public;~~
5. ~~Maximize efficient outdoor water use so that outdoor use of potable water comprises only a small portion of total water use, with a long-term goal of further reducing demand through reliance on alternative irrigation sources (e.g., rainwater harvesting and reclaimed wastewater) and water-wise landscaping techniques; and~~
6. ~~Promote public awareness of the long-term economic and environmental benefits of conserving water to build public support for all aspects of water conservation and efficiency, and to influence behavior to maximize conservation by individuals and institutions.~~

~~*Note*: In this document the term "water supplier" refers to public water suppliers, private water suppliers, and water districts; and the term "communities" refers to cities and towns.~~

Each chapter begins with a bulleted list of target audiences based on the chapter's content, to help guide readers to the areas most useful to them. Additionally several chapters include lists of additional resources, tools, and references, and a set of appendices offer additional detail, background, and guidance.

1.0 Comprehensive Water Resource Planning and Drought Management Planning

This chapter applies primarily to:

- *Water suppliers*
- ~~*Water distributors*~~
- *Municipal ~~governing~~ bodies, boards, and departments*
- *State policy and regulatory entities*

Several ~~anthropogenic~~human-influenced components impact a watershed's hydrological cycle – water withdrawals, wastewater discharges, and land-use decisions~~, including their~~ that impact ~~on~~ stormwater flows. Together, these components can have a significant influence on the quantity and quality of water. An integrated approach is needed to keep water local and to begin to address and mitigate any hydrological imbalances that result. Water conservation is a major component of this approach and, as with energy conservation, is often the least costly and least damaging additional source of water. Planning for future upgrades, development, or expansion of water infrastructure within a community must take into consideration the interdependence of these three components.

~~Several guidance documents are available to assist communities with an integrated approach to water resources planning. These include guidance for developing the Local Water Resources Management Plan (Appendix B of the Interbasin Transfer Act Performance Standards,[7] WRC 2001), and the Integrated Water Resources Management Plan[8] (MassDEP 2007).~~

The Local Water Resources Management Plan~~, required by the WRC for all communities that have gone through the Interbasin Transfer Act approval process,~~ can provide a framework for implementing these Standards and establishing long-term priorities and plans for system maintenance, source protection, and, as necessary, new source development. The goal of the plan is to integrate water supply, wastewater, and stormwater planning at the community, water, sewer, or stormwater district, or water or sewer authority level.

Communities with severe water resource management problems may benefit from an Integrated Water Resources Management Plan (IWRMP). Components of an IWRMP may be triggered by the Massachusetts Environmental Policy Act (MEPA) or the Interbasin Transfer Act. The ~~Wastewater~~Clean Water State Revolving Fund also encourages integrated water resources planning. The IWRMP may encompass an assessment of a community's existing water supply, wastewater, and stormwater practices and the impacts of these on the water balance in the watershed. It also identifies future needs and evaluates alternative approaches to meet those needs.

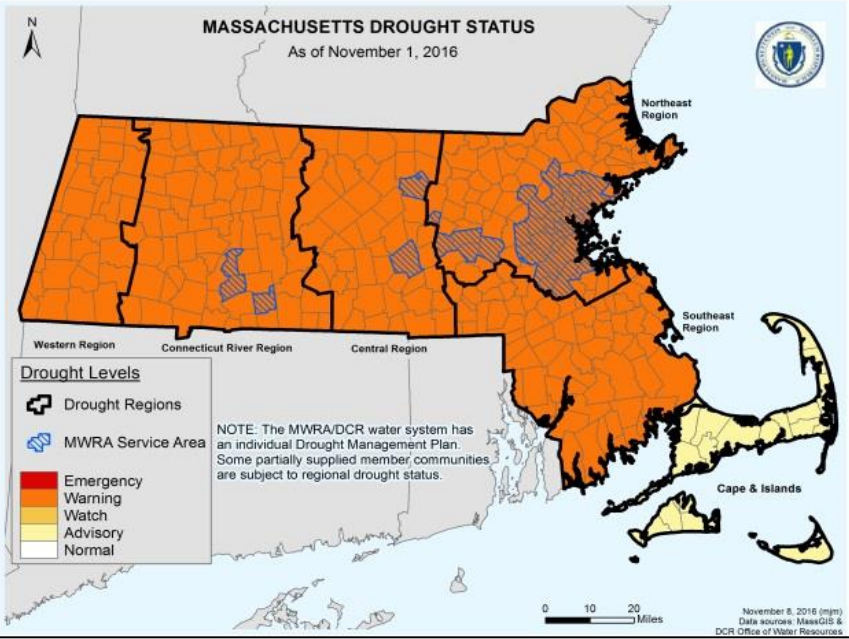


Figure 1.1 Massachusetts Official Drought Status as of November 1, 2016

[7] ~~http://www.mass.gov/dcr/waterSupply/i~~

[8] ~~http://www.mass.gov/dep/water/laws/iv~~

Drought~~/~~ or emergency management plans are another important component of water supply and demand management programs. Pro-active planning for low rainfall conditions has assumed greater significance in light of the 2016-2017 drought, when much of the state was at Drought Level 4 (out of 5) for a prolonged period of time (see Fig. 1.1). Reductions in water use, increased water efficiency, examining and resurrecting emergency connections and overall planning for long-term water deficits and their impacts on various users will go a long way in creating a sustainable water supply for communities. Each public water supplier should have a written plan to respond to both naturally induced and human-made emergencies. A demand management plan that incorporates seasonal water use strategies is important ~~to~~for assisting water suppliers ~~in reducing~~to reduce high seasonal demands and ~~avoiding~~avoid excessive strain on the water supply and distribution system or on the environment (as described in ~~Section~~Chapter 9.0, ~~Lawn and Landscape~~Outdoor Water Use).

1.1 Standards

1. **Develop a drought management plan** that follows American Water Works ~~Association~~Association's Manual of Water Supply Practices M60: Drought Preparedness and Response (AWWA, 2011), and any state-developed drought ~~management~~ planning guidance ~~(AWWA 2002).~~. Develop strategies appropriate to the system to reduce daily and seasonal peak demands and develop contingency plans to ~~ameliorate~~address the impacts of drought, seasonal shortages and other non-emergency water supply shortfalls.
2. **Develop emergency ~~management~~response plans** as per MassDEP requirements ~~(MassDEP Feb. 1997: Declaration of a State of Water Supply Emergency or the latest available version).~~[9].
3. **Develop a written program to comply with these Conservation Standards** and, where possible, with the recommendations outlined in this document, in the operation and management of the water supply systems.
4. **Make the above documents readily available** to personnel from all municipal departments to facilitate compliance and, if necessary, enforcement.

1.2 Recommendations

1. **Integrated Planning –** Infrastructure planning evaluations within communities should include water supply, wastewater, and stormwater with greater emphasis on the issue that is most problematic. ~~Planning should follow either: a) the MassDEP~~To assist with this integrated planning, see MassDEP's guidance for ~~Integrated Plans (MassDEP 2007); or b) the Water Resources Commission guidance for a Local~~ Water Resources Management ~~Plan (WRC 2001).~~Planning[10]. The plans should be updated periodically. Specific principles that should be considered include the following:
    - Stormwater. Stormwater is often a significant component of the water budget ~~and~~. How it is managed can ~~influence the amount of water~~help determine whether it is transported ~~away from~~ quickly out of a subbasin~~. The Water Policy includes a recommendation to "Promote stormwater recharge close to its site of origin." Standard No. 3 of the Massachusetts Stormwater Management Standards requires that "Loss of annual recharge to~~ as direct runoff to streams and rivers or whether

[9] http://www.mass.gov/eea/agencies/massdep/water/drinking/water-systems-ops.html#12
[10] http://www.mass.gov/eea/docs/dep/water/laws/i-thru-z/iwrmp.pdf

it recharges the groundwater ~~shall be eliminated or minimized through the use of~~and helps maintain a more natural hydrologic cycle in a subbasin. Integrated planning efforts should recognize stormwater as a resource and promote its recharge through infiltration measures including environmentally sensitive site design, low impact development ~~techniques~~[11], stormwater best management practices, and good operation and maintenance~~." (MassDEP 2008) Integrated planning efforts should recognize stormwater as a resource, especially with regards to its potential for providing recharge to the hydrologic system through infiltration or controlled surface water replenishment designs. As recommended in the Water Policy and Massachusetts Stormwater Management Standards (MassDEP 2008), communities should reduce the amount of impervious surface in new development and use Low Impact Development (LID) techniques to control stormwater runoff and increase recharge.~~[12] ~~–~~.

- Wastewater. Infrastructure often transports wastewater out of its basin of origin, ~~thus~~ disturbing the water balance and depleting local streamflow and groundwater. ~~To mitigate this, options such as decentralized treatment plants and recharge and reuse should be strongly considered. The Water Policy includes a recommendation to "increase treated wastewater recharge and reuse" and states that "Infiltration and recharge of water and treated wastewater into the ground will~~To help replenish aquifers, enhance riverine base flows, and maintain healthy flow levels even in high-demand summer months~~." As recommended in the Water Policy~~, options such as decentralized treatment plants, local recharge, and water reuse should be strongly considered. With appropriate considerations for treatment and water quality, communities should consider use of reclaimed water for ballparks, golf courses, driving range fields, and other recreational irrigation, as well as for large-scale development projects.[13]

- Infiltration and Inflow (I/I). Infiltration is defined as groundwater that enters the wastewater collection system through physical defects such as cracked pipes/manholes or deteriorated joints. Typically, many sewer pipes are below the surrounding groundwater table; therefore leakage of clean groundwater into the sewer (infiltration) is a broad problem. Where sewer pipes run through Zone II areas or other land areas contributing flow to water supply withdrawal points, ~~I/I~~infiltration to those pipes can significantly reduce the yield of that water supply. Inflow is extraneous flow entering the wastewater collection system through point sources. Inflow may be directly related to stormwater runoff from sources such as roof leaders, yard and area drains, sump pumps, manhole covers, and cross-connections from storm drains or catch basins. Inflow may also be contributed from non-storm-related point sources, such as leaking tide gates, cooling-water discharges, or drains from springs and swampy areas ~~(Infiltration/Inflow Task Force March 2001).~~[14].

  I/I removal plays an important role in balancing the water budget by minimizing the amount of groundwater and stormwater lost into wastewater systems. As ~~applicable,~~communities develop their

[11] Low Impact Development (LID) is an approach to land development and stormwater management that encourages groundwater infiltration, runoff detention and filtration. The primary tools of LID are site design to minimize land and vegetation disturbance and the use of landscaping features and naturally vegetated areas to encourage detention, infiltration and filtration of stormwater on site. Other tools include water conservation and use of pervious paving surfaces. See the low-impact development section of the Water Resources Commission website.

~~[12] Low Impact Development (LID) is an approach to stormwater management that encourages groundwater infiltration, runoff detention and filtration. LID techniques infiltrate and filter stormwater at the lot level, instead of conveying the water away from the project. The primary tools of LID are site design to minimize land disturbance and the use of landscaping features and naturally vegetated areas, which encourage detention, infiltration and filtration of stormwater on site. Other tools include water conservation, use of pervious surfaces, and maintaining existing vegetated areas. The national LID manual (Low Impact Development Design Strategies: An Integrated Design Approach) can be found on the EPA website at: http://www.epa.gov/owow/nps/lid/. Also see the low-impact development section of the Water Resources Commission website.~~

[13] Regulations on reclaimed water (promulgated by MassDEP in March 2009) are available at ~~314 CMR 20.00~~314 CMR 20.00: Reclaimed Water Permit Program and Standards.

[14] Infiltration/Inflow Task Force March 2001

I/I plans as required by 314 CMR 12.04, communities should strive to implement the seven overall goals approved by the I/I Task Force, as applicable:

- Eliminate all sewer system backups;
- Minimize, with a long-term goal of eliminating, health and environmental impacts of sewer system overflows related to I/I;
- Remove all (and prevent new) inflow sources from separate sanitary systems;
- Minimize system-wide infiltration;
- Educate and involve the public;
- Develop an operation and maintenance program; and
- Improve funding mechanisms for identifying and removing I/I.

The Net Blue Project

A collaborative initiative of the Alliance for Water Efficiency, the Environmental Law Institute, and River Network

Explore opportunities for water-neutral community development, in which offsets such as rainwater harvesting and conservation retrofits help ensure that new growth results in no net additional demands on the water supply system. Offsets can be targeted toward individual projects or applied at a wider level through local bylaws or ordinances. The Net Blue Project provides customizable tools and resources supporting this concept.

- Water Supply. Water supply development, whether for residential use, industrial use, development, irrigation or fire protection, needs to be within the water budget of the local basin. In many cases, water is moved via infrastructure from one basin to another, thus dewatering one basin in order to support another. This can lead to low streamflows, habitat impairment and other ecological problems in the donor basin. Ideally, the water should be used and discharged locally so as to create the least amount of disturbance to the water balance and the local ecology, and recharged whenever possible. In cases where transport of water across basin lines is required, alternatives must be considered, as required by the Interbasin Transfer Act. The preferred alternative would be one that is most protective of the environment while providing the most time- and cost-sensitive option.

2. **Communicate with other local officials –** To aid in community planning and decision making, water suppliers should keep local officials (Conservation Commissions, Zoning and Planning Boards, Selectmen, and other agencies concerned with development) regularly informed of water consumption and supply availability. These local officials should, in turn, ensure that their actions affecting land or water use do not impair the integrity of the public water supply by enabling source water to be diminished in quality or quantity, or by permitting development that exceeds the capacity of the system or ~~impair~~impairs the quantity or quality of future potential sources.

3. **Water Banks/Water-Neutral Community Development –** Communities and water suppliers, especially those prone to capacity problems or experiencing significant growth, should consider establishing a ~~Water Bank~~water bank. The purpose of a ~~Water Bank~~water bank is to provide a water supplier, developer, or municipality with required resources to maintain or reduce existing demand on water resources, while accommodating the water needs of existing and future development. For example, a water bank could require that anyone seeking to connect to the municipal water supply must reduce from the existing water supply system or end users at least two gallons for every new gallon that is required. Alternatively, a developer seeking connection to a wastewater collection system may reduce infiltration and inflow or recharge stormwater. ~~For~~See Appendix A for further information on water banks, ~~see Appendix A~~and sidebar on "water-neutral community development" tools available through the Net Blue Project.

1.3 Resources

- MA Water Resources Commission Interbasin Transfer Act Performance Standards Guidance, Update 2001, Appendix B: Local Water Resources Management Plan Outline. Available at: https://edit.mass.gov/files/documents/2017/08/31/Performance%20Standards%20Guidance%20Document.pdf
- Net Blue – a collaborative initiative of the Alliance for Water Efficiency, the Environmental Law Institute, and River Network (2015). Information, workbooks, spreadsheets, and examples of opportunities to pursue "water neutral" community growth.
  Available at: http://www.allianceforwaterefficiency.org/net-blue.aspx
- American Water Works Association (2011). *Manual of Water Supply Practice M60: Drought Preparedness and Response*, (or most recent edition).
  Available at: https://www.awwa.org/store/productdetail.aspx?productid=26750
- American Water Works Association (2006). *Manual of Water Supply Practice M52: Water Conservation Programs - A Planning Manual*, (or most recent edition).
  Available at: https://www.awwa.org/store/productdetail.aspx?productid=6740
- American Water Works Association (2017). *Manual of Water Supply Practice M50: Water Resources Planning, third edition*, (or most recent edition).
  Available at: https://www.awwa.org/store/productdetail.aspx?productid=62573688
- ANSI/AWWA G480-13 (2013, First Edition): Water Conservation Program Operation and Management Standard, (or most recent edition).
  Available at: https://www.awwa.org/store/productdetail.aspx?productid=35009354
- Vickers, Amy. 2001. *Handbook of water use and conservation.* Amherst, MA: WaterPlow Press.

~~This page intentionally left blank~~

~~2.0 System Water Audits and Leak Detection~~

1.4 Related Appendices

- Appendix A: Water Bank Guidance
- Appendix B: Model Bylaws

2.0 Water Loss Control

This chapter applies primarily to:

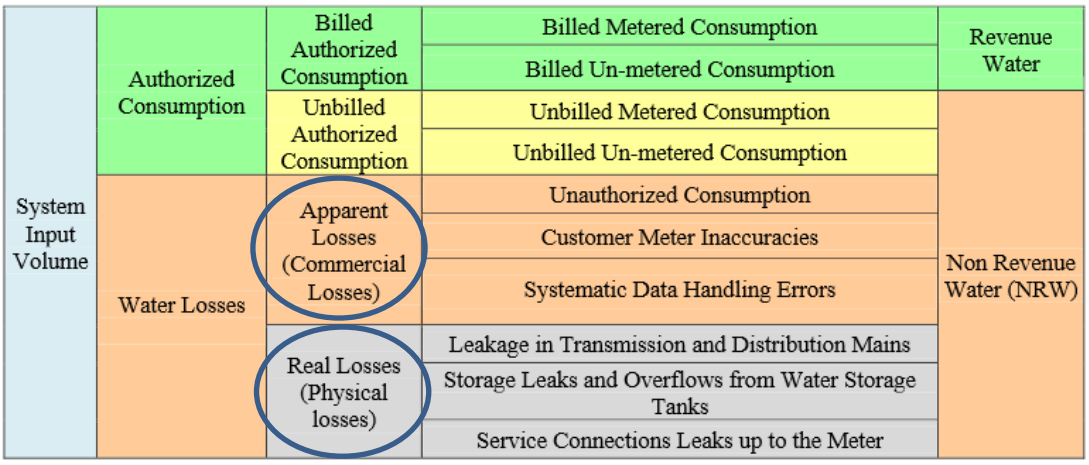
- *Water suppliers*
- ~~*Water distributors*~~
- *Municipal ~~governing~~ bodies, boards, and departments*

Water loss control is the implementation of best management practices to ensure that water entering a distribution system is efficiently delivered to each point of use. Water loss control measures typically fall into two categories - accounting for the water distributed in the system and managing the infrastructure to prevent system losses. Evaluating the measures for their effectiveness is also a part of water loss control.

Performing a water audit is an important first step of water loss control. Water audits provide water suppliers with ~~an effective~~a means of accounting for water, identifying and reducing water and revenue losses, and making better use of water resources. Audits help suppliers to categorize losses as either real losses from a system (such as distribution leakage, service connection leakage, and tank leakage and overflows) or apparent losses (such as data handling errors, unauthorized consumption, and metering inaccuracies). Figure 2.1 shows how real and apparent losses (circled) are defined within the American Water Works Association (AWWA)/International Water Association (IWA) water balance categories. The overall goal of the water audit is to help the public water supplier select ~~and implement programs~~strategies to reduce ~~distribution system~~real and apparent losses. ~~In addition to~~

Figure 2.1 The AWWA/IWA Water Balance

From U.S. Environmental Protection Agency. 2010 "Control and Mitigation of Drinking Water Losses in Distribution Systems," EPA 816-F-10-019



Determining and implementing intervention strategies is the next step in water ~~audits, regular~~loss control. Data from a water audit can be used for a component analysis to further categorize real losses in order to choose the most appropriate leak reduction measures. Managing infrastructure to minimize real losses is an important part of water loss control. Infrastructure maintenance and replacement, minimization of the number of joints and fittings, and minimization of leak repair times are strategies to control real losses. Regular leak detection survey and tracking programs provide critical information on ~~system water~~real losses and are an essential component of system management. Detecting and fixing leaks can provide one of the largest returns on investment, especially in older systems. Another real loss control strategy is pressure management. Systems operating at higher pressures will have higher volumes of water lost through leaking

joints and cracks in the pipe as well as increased leak frequency and pipe breaks. By optimizing pressure, suppliers can reduce leakage and can reduce stress on the distribution system infrastructure.

~~An important measure of system efficiency is the volume of unaccounted for water (UAW). UAW is defined as the residual resulting from the total amount of water supplied to a distribution system as measured by master meters, minus the sum of all amounts of water measured by consumption meters in the distribution system, and minus confidently estimated and documented amounts used for certain necessary purposes as specified by the MassDEP.~~

Evaluating the activities undertaken for their effectiveness is integral to successful water loss control. Evaluating data, tracking progress, comparing results to industry benchmarks and performance indicators, and identifying areas for improvement are the last steps in water loss control and are important for refining water loss control activities. A formal water loss control program consisting of all the above practices together with goals, assessment measures, and responsibilities will help suppliers:

- reduce unnecessary water withdrawals, environmental impacts from those withdrawals, and pumping and treatment costs;
- bolster revenue collection by addressing metering inaccuracies and unauthorized water use; and
- target maintenance efforts and infrastructure investments to minimize system disruptions and improve system integrity.

The Massachusetts Department of Environmental Protection (MassDEP) requires that public water suppliers that use more than 36.5 million gallons per year (annual average greater than 100,000 gallons per day) complete a basic water audit by calculating unaccounted-for water (UAW) as part of their Annual Statistical Report (ASR) submittal. UAW can include both real and apparent losses. Examples of UAW include, but are not limited to unavoidable leakage, recoverable leakage, meter inaccuracies ~~(unless they fall under the category of source meter calibration, which allows for adjustment per results of source meter calibration required in the MassDEP's Annual Statistical Report (ASR) audit),~~ errors in estimation of stopped meters, unauthorized hydrant openings, illegal connections, data processing errors, and undocumented ~~fire fighting uses~~firefighting uses. UAW is defined as the residual resulting from the total volume of water supplied to a distribution system as measured by master meters, minus the sum of all volumes of water measured by consumption meters in the distribution system, and minus confidently estimated and documented volumes used for certain necessary purposes as specified by the MassDEP. In addition to a calculation for UAW volume, MassDEP's ASR has a calculation for UAW percentage in order to measure water system efficiency.

~~Certain~~These volumes specified by MassDEP that can be confidently estimated and documented in writing ~~can be~~and excluded from the calculation of UAW~~. As of the 2010 ASR, these~~ include fire protection, hydrant and water main flushing; water main flow testing; water main construction; storage tank overflow and drainage; bleeding or blow-offs; sewer and stormwater system flushing; street cleaning; ~~source meter calibration;~~ and major main breaks, within parameters provided by MassDEP. ~~Any adjustments made as a result of the properly documented source meter calibration should be provided as required by the ASR.~~ Generally, leakage is classified as UAW; however, individual major water main breaks can be discounted on a case-by-case basis.

~~All public water suppliers are required to calculate UAW as part of the ASR submittal to MassDEP. The industry standard for UAW ranges from 10% to 15%, depending on the reference consulted.~~ It is important to note that for many public water systems, a significant portion of UAW is not water that is physically wasted, misused or ~~lost,~~leaked (real losses), but water that ~~may be~~is used for legitimate purposes but is not ~~accurately measured,~~easily estimated or measured ~~at all~~.

2.1 Standards

1. **Conduct the ASR water audit on an annual basis** using the MassDEP Water Audit Guidance Document (http://www.mass.gov/dep/water/approvals/wmgforms.htm#audit).

1. **Conduct complete system wide****Develop and Implement a Water Loss Control Program** – Communities should develop and implement a water loss control program. Guidance on water loss control programs can be found in EPA's "Control and Mitigation of Drinking Water Losses in Distribution System" as well as AWWA's M36. Elements to include in a water loss control program are:

   a. An annual water audit to better focus efforts on reducing real and apparent losses.
   b. Program goals and assessment measures.
   c. Record keeping, including tracking losses, leaks, and repairs, and tracking other volumes such as Confidently Estimated Municipal Use as defined by MassDEP.

Leakage management including leak detection **every two (2) years** unless:

- The results of the ASR water audit indicate that leakage constitutes a small portion of the system's unaccounted for water; or
- The volume of leaks detected through the most current leak detection survey (conducted within the previous two years) indicates insignificant leakage.

Note: In these cases, the water supply system should work with the regulatory agency (ies) to develop a more efficient schedule for leak detection.

2. **Meet or demonstrate steady progress towards meeting**[15] **10% UAW as soon as practicable**, especially in those communities in a basin with a higher level of stress[16]. The WRC will periodically monitor the state-wide progress of communities using information provided in the ASR water audit.

3. **Conduct field** surveys **for leaks and** , zone flow analysis, leak repair **programs** in accordance with the most recent edition of AWWA Manual 36 and any MassDEP guidance documents.

   a.d. **Repair all leaks found as expeditiously as possible**. Each community establish a priority system to implement leak repairs.(as described in more detail Leaks causing property damage or affecting public safety should be fixed immediately. Further guidance is referenced in recommendation 3 below. Standard #4), and pressure management.

Recommendations

2. Comprehensive Water Audits – Conduct a comprehensive audit every 5 to 10 years depending on the findings of the ASR audit. A comprehensive audit is strongly recommended for communities/systems showing significant and unexplainable increases in UAW from one year to the next, and for communities/systems that are consistently unable to meet regulatory standards for UAW.

   a.e. System Assessmentassessment and maintenance – To help eliminate and prevent leaks and water loss, water suppliers should perform assessments of their systems on a regular basis to determine where capital improvements are appropriate and incorporate the recommendations into a long-term capital improvement program. Specifically, aged and undersized or structurally deteriorated pipe

[15] Communities already meeting the 10% UAW standard should continue activities to further reduce UAW, taking advantage of advancing technology. The Commonwealth recognizes the existence of circumstances that could affect a community's efforts to fully meet this standard. These circumstances could include aging infrastructure. In such cases, the community should document, as part of its regulatory requirements, all efforts that have been undertaken in order to comply with this standard.

[16] Basin stress as defined by the Water Resources Commission. See WRC publication 'Stressed Basins in Massachusetts, December, 2001' or most recent version.

should be replaced, and structurally sound pipe should be cleaned and lined to ensure long-term structural integrity.

f. ~~Guidance~~Standards for ~~Leak Repair Communities~~installation, repairs, rehabilitation, and replacement of pipe. Poorly executed pipe installation and workmanship can contribute to unnecessary leakage, especially work done on service connections. All pipe work, repairs, and connections should be designed properly, executed properly, and inspected.

2. **Minimize real and apparent losses by meeting or demonstrating steady progress towards an unaccounted-for-water (UAW) percentage of 10% or less as calculated on the Annual Statistical Report form and approved by Massachusetts Department of Environmental Protection (MassDEP) as soon as practicable**. Water suppliers already meeting the 10% UAW standard should continue activities to account for all water and further reduce real and apparent losses, taking advantage of latest technology. The Commonwealth recognizes the existence of circumstances, such as aging infrastructure, that could affect a water supplier's ability to fully meet this standard. In such cases, the water supplier should document, as part of its regulatory requirements, all efforts that have been undertaken in order to comply with this standard, including development and implementation of a Water Loss Control Program.

3. **Conduct complete system-wide leak detection at least every three years.** Conduct more frequent leak detection surveys if needed as part of a Water Loss Control Program.

4. **Repair all found leaks as expeditiously as possible**. Establish a priority system to implement leak repairs. Leaks causing property damage or affecting public safety should be fixed immediately. ~~water~~ Small leaks, if left unrepaired for long periods of time, can result in a greater volume of water loss than a large leak repaired more quickly. Water suppliers looking for ~~more specific~~ guidance on ~~timelines for repairing leaks~~ the effect of time on leakage losses and the minimization of leakage run time should refer to ~~documentation recommended by MassDEP:~~AWWA Manual M36 "Water Audits and Loss Control Programs."

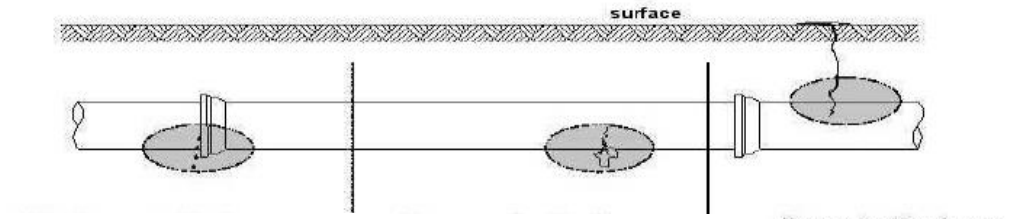
- ~~AWWA Manual M36 and the ANSI/AWWA Standard G200-09 for Distribution System Operation and Maintenance~~
- ~~MWRA regulations, 360 CMR 12.09: Leak Repairs~~

2.2 Recommendations

1. **Water Audits** – As a component of the Water Loss Control Program, conduct a desktop or paper top-down audit every year. This process uses existing information and records to do an annual water balance. The Environmental Protection Agency's (EPA) "Control and Mitigation of Drinking Water Losses in Distribution System" provides guidance on top-down audits and the basic steps. Examples of top-down audit methodologies are AWWA's Manual 36 and AWWA's Free Audit Software©, which is based on M36 and available on the AWWA website. Depending on the findings of the top-down audit, conduct problem-specific bottom-up audit(s) and activities to better refine numbers, identify sources of loss, and concentrate efforts on problem areas. Bottom-up audits and activities may consist of field measurements such as district metered area analyses, detailed investigations of practices such as metering, and a component analysis of real losses. A component analysis categorizes real losses into background leakage, un-reported leakage, and reported leakage. Water Research Foundation's "Real Loss Component Analysis: A Tool for Economic Water Loss Control" and the accompanying software

model provides guidance for a component analysis and evaluation in order to identify least cost real loss reduction strategies (see Figure 2.2 for the components of leakage and control strategies). Top-down and bottom-up audit analyses are strongly recommended for communities/systems showing significant and unexplainable increases in UAW from one year to the next, and for communities/systems that are unable to meet regulatory standards for UAW. Even if a community/system is meeting 10% UAW, an audit can prove useful. A water supplier can further confirm the basis of data entries in the water audit by having the audit "validated" by a qualified technical expert. The reference titled "Water Audits in the United States: A Review of Water Losses and Data Validity" cited in the Resources section of this chapter has more information about the levels of audit validation.

Figure 2.2 Components of Leakage and Control Strategies



Background Leakage	**Unreported Leakage**	**Reported Leakage**
Un-reported and un-detectable using traditional acoustic equipment.	Often does not surface but is detectable using traditional acoustic equipment.	Often surfaces and is reported by the public or utility workers.
Tools • **Pressure Stabilization** • **Pressure Reduction** • **Main and Service Replacement** • **Reduction in the Number of Joints and Fittings**	**Tools** • **Pressure Stabilization** • **Pressure Reduction** • **Main and Service Replacement** • **Reduction in the Number of Joints and Fittings** • **Proactive Leak Detection and Repair**	**Tools** • **Pressure Stabilization** • **Pressure Reduction** • **Main and Service Replacement** • **Optimized repair time**

Source: Tardelli Filho, J. 2004. SABESP. Sao Paulo, Brazil: Internal reports, taken from American Water Works Association, 2016 "Water Audits and Loss Control Programs M36"

2. **Pressure management** - Although the topography of Massachusetts may make pressure management difficult in some systems, its use for water loss control should still be considered. There are several ways pressure management can be implemented including: a separate zone may be created with a pressure-reducing-valve or a pressure-reducing device that responds to demand or pressure, or is set to a time; or system-wide pressure may be reduced during low demand periods (e.g. at night or seasonally). Some systems may benefit especially if they have a single pressure zone and are having difficulty managing their water tanks and have water age issues. Systems need to consider water quality if creating a zone results in dead ends as well considering the impacts of reduced pressured on firefighting flow. Evaluating a system for pressure management is important if a system is calculating its unavoidable-real-losses (i.e. unavoidable leakage) using the equation developed by the International Water Association Water Loss Task Force; if a system or part of a system is at higher than needed pressure, unavoidable-real-losses may be higher than need be.

3. **Service Connection Leakage Control** - A significant portion of system leakage can be from service connections. Suppliers should have regulations in place to require property owners to fix leaks on their

properties in a timely manner. Suppliers may also consider the use of meter pits at the beginning of service lines instead of meters within a house or building because if a customer is charged for leakage, there is an incentive for the leak to be fixed. Other strategies for suppliers include a policy for service replacement by the supplier, especially as part of a water main replacement, and the inclusion of service connections in leak detection surveys.

~~1.~~4. **Leak Detection Services** – ~~Communities and water~~Water suppliers should consider pooling resources to procure leak detection services, similar to the ~~MWRA~~Massachusetts Water Resources Authority program that procures a leak detection consultant for a three-year period and makes the consultant services available to customer communities on a task order basis. The three-year procurement ~~includes~~results in lower pricing ~~for~~because it addresses a ~~larger volume of service (about 5000 miles~~greater length of water main (about 5,000 miles) than would be procured by any one community (typically ~~individual community systems are~~ 100 to 200 miles ~~of water main~~).

5. **Automated Leak Detection** – Water suppliers should consider investing in an automated remote leak detection system. Leak listening devices may be installed permanently or temporarily throughout a system or just in problem areas. Noise information is logged and then automatically downloaded and processed. Alerts may be generated if there is a suspected leak. In addition, there are automated leak detection devices that can be installed on customer meters. These devices are able to listen for leaks on customer services and the near portion of the main.

6. **Pressure Reduction** – The Massachusetts Plumbing Code (248 CMR 10.14(g) Excessive Water Pressure) requires that a pressure-reducing valve be installed on the water service connection to a building when the supplied water pressure is 80 pounds per square inch (psi) or greater. Pressures of 80 psi or greater can damage building plumbing systems and fixtures and cause higher leakage and flow rates. Generally, service areas that can exceed 80 psi are found at low points or near water pumping stations. A licensed plumber can assess the need for, install, and adjust pressure-reducing valves thereby protecting a property owner's plumbing and conserving water. Water suppliers should evaluate their systems to determine where sustained system pressures may exceed 80 psi in order to respond to user inquiries and to work with plumbing inspectors and property owners to make them aware of the potential need of a pressure-reducing valve.

~~2.~~7. **Establish penalties and/or fines for stealing water** – Those with authority to set and enforce penalties for theft of public water ~~(including but not limited to~~such as municipal Water Commissioners, Town Selectmen, and public water suppliers~~; not including private water suppliers)~~ should develop a new bylaw/ordinance or amend existing bylaws/ordinances to establish a penalty, by providing authority to levy a significant fine and/or penalty, that may be enforced criminally or ~~noncriminally.~~otherwise. Private water suppliers are encouraged to work with those with authority to develop bylaws and ordinances for water theft. Massachusetts General Law (MGL Ch. 165, Sec. 11), establishes penalties for water theft consisting of triple the amount of damages or $1,000, whichever is greater, or imprisonment, or both~~. The language of MGL Ch. 165, Sec. 11 is included in Appendix B. Example language from a recent bylaw passed in East Bridgewater, Massachusetts, on unauthorized use of a fire hydrant is also included in Appendix B.~~ [17].

[17] MGL Chapter 165, Section 11: Intentional injury to or interference with meter; penalty

2.3 Resources

- U.S. Environmental Protection Agency. 2013 "Water Audits and Water Loss Control for Public Water Systems," EPA 816-F-13-002
  https://www.epa.gov/dwcapacity/water-efficiency-and-conservation-resources-small-drinking-water-systems

~~3.~~ U.S. Environmental Protection Agency~~Remote Reading – Communities/water suppliers should consider investing in an automated remote leak detection system.~~

~~4. Pressure Reduction – The Massachusetts plumbing code (248 CMR 10.14(g) Excessive Water Pressure) requires that a pressure reducing valve be installed on the water service connection to a building when the pressure is eighty (80) pounds per square inch (psi) or greater. Community water suppliers should evaluate existing water system regulations in order to ensure compliance with this regulatory requirement. This evaluation could include the establishment of maximum pressures for users as a conservation measure. Maintaining water pressure within the regulatory limit conserves water. Water suppliers should map their jurisdictions to show areas in which water pressure may exceed the limit in the absence of pressure reducing valves. They should recommend to and assist the plumbing inspector in conducting periodic surveys to determine whether the pressure reducing valves are functioning properly, and take remedial action as needed.~~

~~This page intentionally left blank~~

- . 2010 “Control and Mitigation of Drinking Water Losses in Distribution Systems,” EPA 816-F-10-019 https://www.epa.gov/dwcapacity/water-efficiency-and-conservation-resources-small-drinking-water-systems
- American Water Works Association (2016). *Manual of Water Supply Practice M36: Water Audits and Loss Control Programs*, (or most recent edition). Available at: https://www.awwa.org/store/productdetail.aspx?productid=51439782
- American Water Works Association, 2014 Free Audit Software© v. 5.0 available on AWWA’s website, or most recent edition http://www.awwa.org/resources-tools/water-knowledge/water-loss-control.aspx
- Water Research Foundation, 2014 “Real Loss Component Analysis: A Tool for Economic Water Loss Control” Web Report #4372a http://www.waterrf.org/Pages/Projects.aspx?PID=4372
- Water Research Foundation, 2014 “Leakage Component Analysis Model” and the “Leak Repair Data Collection Guide”. http://www.waterrf.org/resources/pages/PublicWebTools-detail.aspx?ItemID=27 http://www.waterrf.org/resources/pages/PublicWebTools-detail.aspx?ItemID=28
- Water Research Foundation, 2015 “Water Audits in the United States: A Review of Water Losses and Data Validity” Web Report #4372b http://www.waterrf.org/Pages/Projects.aspx?PID=4372
- Georgia Association of Water Professionals, 2016 “Georgia Water System Audits and Water Loss Control Manual” produced for Georgia Department of Natural Resources http://c.ymcdn.com/sites/www.gawp.org/resource/resmgr/Water_Loss_Audit_files/GA_Water_Loss_Manual_V2.0.pdf

3.0 Metering

This chapter applies primarily to:

- *Water suppliers*
- ~~*Water distributors*~~
- *Municipal facilities and public works personnel*
- *State facilities personnel*
- *Industrial facilities, commercial facilities, and other consumers who own large meters (such as residential institutions and ~~multifamily~~multi-family complexes)*

Complete system metering informs both ~~the supplier~~suppliers and ~~the~~ customers of how much water they are using, provides the supplier with valuable knowledge of customer use patterns, assists in demand management programs ~~such as water audits~~, and enables the supplier to bill the customer more accurately based on actual use. Complete system metering also provides essential data for managing water resources state-wide. With accurate knowledge about current water use, the supplier can more effectively identify potential water savings and assist specific users to implement water-saving measures, thereby providing the opportunity to reduce overall system demand. This would also free up water that may be needed by new customers, and enable the retention of more water in the natural environment. In addition, full and accurate metering means that water suppliers can be paid for all the water they provide, without lost revenue from unmetered or inaccurately metered water.

3.1 Standards

1. **Meter water sources to measure and record withdrawals of both groundwater and surface water and measure and record purchased water**. In addition, if there is potential for losses between withdrawal and entry to the distribution system, measure and record finished water.

2. **Ensure 100% metering of all water uses, including all indoor and outdoor water use at all municipal and state facilities (**~~schools, school athletic fields, etc.). Properly size the service lines and meters for all water distribution system users to meet AWWA performance standards. See AWWA Manual M6, Water Meters – Selection, Installation, Testing, and Maintenance.~~**such as schools and athletic fields).**

~~**Increase billing frequency**. For domestic accounts, bill customers on actual, not estimated, meter readings.~~3. **Implement a water meter repair/replacement policy and program, including a budget for the calibration, repair, and replacement of all sources of supply and distribution network water metering systems**. Consult American Water Works Association (AWWA) Manual M6 "Water Meters- Selection, Installation, Testing, and Maintenance" for guidance.

4. **Seal all water account metering systems against tampering and periodically inspect to ensure water works system integrity.**

5. **Calibrate source, raw, treatment, and finished water master meters at least annually, regardless of meter specification.**

6. **Calibrate and or replace all meters according to their type and specification.** Water suppliers should calibrate or establish the necessary regulations and controls to ensure that owners of large customer meters calibrate the meters according to the recommended interval and provide the results as part of a reporting requirement. The AWWA Standards (AWWA Manual M6) can be consulted for guidance on calibration requirements and accuracy standards. Time periods for calibration are generally based on meter size. Meter wear is a function of the amount of water metered rather than the passage of time.

7. **Properly size meters to handle required water flow rate and ensure a high level of metering accuracy.** For guidance, see AWWA Manual M6, Water Meters – Selection, Installation, Testing, and Maintenance and AWWA Manual M22 Sizing Water Service Lines and Meters.

8. **Billing frequency. If billing frequency is less than quarterly (i.e. annual or biannual), implement quarterly or more frequent billing as soon as practicable.** Bill customers on actual, not estimated, meter readings.

3.2 Recommendations

1. **Billing –**

- Indicate the rate structure on the water bill.
- ~~possible.~~Bill monthly (or at a minimum bi-monthly). This helps customers keep better track of their water use, take note of seasonal variations or potential leaks, and make adjustments in their water use accordingly. Frequent billing also reduces the risk of unexpectedly high water bills and unhappy customers resulting from undetected new leaks.

~~1. **Implement a water meter repair/replacement policy and program**. The program should replace meters by size and time based on AWWA standards (AWWA Manual M6). Establish an annual budget line item for the calibration, replacement, and repair of all sources of supply and distribution network water metering systems.~~

- Base bills on estimated flows when metering is disabled or bypassed.
- Read and bill temporary meters on a corresponding usage period.

~~**Seal all water account metering systems against tampering and periodically inspect to ensure water works system integrity.**~~

~~**Calibrate** any meter used to record quantity, according to its type and specification. The AWWA Standards (AWWA Manual M6) can be consulted for calibration requirements and accuracy standards. Time periods for calibration are generally based on meter size. Meter wear is a function of the amount of water metered rather than the passage of time.~~

~~2. **Properly size water service lines and meters** to handle required water volumes and ensure a high level of metering accuracy.~~

~~3. Water suppliers **establish the necessary regulations and controls** to ensure that owners of large meters (1.5 inches or greater) calibrate the meters annually and provide the results as part of an annual reporting requirement.~~

~~Recommendations~~

~~1. Funding for Meter Replacement – The Commonwealth should make financial assistance (e.g. matching grants) available for meter replacement and automatic meter reading equipment.~~

~~2.1.~~~~For billing,~~

- ~~Indicate the rate structure on the water bill.~~
- ~~For large users read meters and generate bills monthly.~~
- Where applicable, share the cost of reading and billing between the water and sewer operations.
- ~~Utilities move~~Move toward adopting billing software that allows customers to compare their individual water use for the previous 12 months, and compare their water use with average water use for their customer class.

- Report average water use in gallons per day and provide a table or brochure on residential water use that includes: residential gallons per capita per day (rgpcd~~),~~); a comparison of the average cost of bottled water to the cost of tap water~~,~~; a comparison to water-use standards~~,~~; and promotion of efficient water-use behavior (see Appendix C).
- ~~Printed~~Along with water bills, provide printed material ~~encouraging residents to save money by conserving water, providing~~with advice on topics such as how to conserve~~, announcing~~ water and the availability of rebates~~, etc. should accompany the water bill~~ (see Appendix C).
- ~~Water bills could include~~Include an automated "thanks for conserving water" message ~~where~~on water bills when use ~~drops~~has dropped over ~~the~~a comparable period the previous year, and a "please do what you can to conserve water" message for users whose water use has increased over the same time period.
- In communities with Automatic Meter Reading systems, set up a web site ~~could be set up~~ to provide secure access to water use-data by customers and water auditors.

~~3.~~2. ~~Remote Reading~~ **Smart Metering** ~~–~~ Communities/water suppliers should consider investing in an ~~automated~~automatic meter reading system (AMR) or advanced metering infrastructure (AMI) that allows remote reading of meters. Remote reading and ~~facilitates~~data collection facilitate more frequent billing ~~to~~which can help improve cash flow, ~~eliminates~~eliminate estimated meter readings, ~~utilizes employees efficiently, supports~~support water audits, ~~detects leaks, monitors UAW, enables~~potentially enable users to track their water use, and ~~provides~~provide water suppliers with more detailed information on water-use patterns in the community ~~that~~. This can be useful in enforcing water-use regulations~~.~~ and investigating water theft and meter tampering. In addition, remote reading can enable suppliers to alert customers of leaks on their side of the meter and can enable suppliers to do a better job of accounting between customer meters and master meters. Overall, smart metering offers opportunities to improve revenue, customer service, and asset management.

~~4.~~3. **Minimize Use of Estimated Data –** Meter reading should be done in a manner that allows for actual data instead of estimated data for ASR reporting.

3.3 Resources

- American Water Works Association (2013). *Manual of Water Supply Practice M6: Water Meters-Selection, Installation, Testing, and Maintenance, fifth edition*, (or most recent edition). Available at: https://www.awwa.org/store/productdetail.aspx?productid=39928480
- American Water Works Association (20143). *Manual of Water Supply Practice M22: Sizing Water Service Lines and Meters, third edition*, (or most recent edition). Available at: https://www.awwa.org/store/productdetail.aspx?productid=44766350

3.4 Related Appendices

- Appendix C: Example Water Bill Insert

4.0 Pricing

This chapter applies primarily to:

- *Water suppliers*[18]
- ~~*Water distributors*~~
- *Municipal ~~governing~~ bodies, boards, and departments*
- *State policy and regulatory entities*

- ~~*State policy and regulatory entities*~~

~~Consumers should be charged the full cost of water. Full cost pricing refers to price levels that recover all the direct and indirect costs associated with providing water, as outlined below in Pricing Standard 1. Full-cost pricing can take the form of any rate structure, so long as all costs are recovered through prices. Pricing should be reviewed and updated often enough to avoid budget shortfalls due to erosion of revenues and increases in costs (such as energy) from inflation.~~

The price of water can be an important ~~demand management tool if set properly. Studies have shown that, to some degree, demand for water can be manipulated by price. Water for necessities (sanitation, cleaning, and cooking) is far less responsive to price than water for~~ driver of water conservation behavior. Moreover, studies show the more discretionary uses ~~(lawn watering, car washing, and swimming pools).~~

~~Rate structures can be categorized as being conservation-oriented (likely to promote conservation), conservation-neutral (neither promoting nor discouraging conservation), or discouraging conservation. Some conservation pricing options include:~~

- ~~Increasing block rates~~
- ~~Seasonal rates~~

~~Increasing block rates charge a higher unit price as consumption rises.~~

~~Seasonal rates, where prices rise and fall according to water supplies and weather conditions (with higher prices usually occurring between April and October), target discretionary uses~~ of water (such as lawn watering~~, sidewalk cleaning, and pool filling). Adopting higher water rates in the summer is strongly recommended as this directly addresses peak~~ and car washing) are those most responsive to price signals. This underscores that water pricing should be a critical part of the Commonwealth's effort to promote water use~~, one of the biggest challenges for water utilities (MAPC 2006). Water consumption typically peaks in the summer when outdoor water use increases and, in some areas, there may be an increase in population due to an influx of vacationers. This is also the time of year when water-dependent organisms and ecosystems are already under considerable stress and can least afford to have water levels further reduced.~~ efficiency among consumers.

~~For effective pricing, water suppliers, communities, and water planners need to consider, at a minimum, the following three issues: i) the service population's ability to afford higher rates; ii) the effects of conservation~~

[18] Pursuant to G.L. c. 164, § 94, G.L. c. 165, § 1, and G.L. c. 21G, § 19, pricing and rate design issues, as they pertain to privately held water suppliers, are regulated by the Department of Public Utilities (DPU). Accordingly, the standards that appear in this chapter do not apply to privately held water suppliers. However, in designing water rates, the DPU recognizes the importance of water conservation and is committed to working cooperatively with the Water Resources Commission and other regulatory agencies to achieve conservation goals.

~~rates on a utility's revenues; and iii) the actual effectiveness of rates in reducing water demand (EPA 2003). Further guidance on these three concepts is provided in pricing guidance documents referenced in footnote 12.~~

~~A variety of rate structures are used throughout Massachusetts. Some are conservation-oriented while others are not. Based on results of a survey of Massachusetts communities (Tighe & Bond 2010):~~

- ~~63% use an ascending rate structure;~~
- ~~6% use seasonal rates;~~
- ~~35% use a flat rate structure; and~~
- ~~2% use a flat fee.~~

~~Billing is another important component of operations that provides an opportunity to enhance conservation if implemented effectively. Billing at a frequency that provides customers the opportunity to regularly evaluate and adjust their use is preferable. Of the Tighe & Bond (2010) survey respondents:~~

- ~~56% use quarterly billing;~~
- ~~34% use a biannual billing cycle;~~
- ~~6% use a monthly billing cycle; and~~
- ~~4% use either an annual, bimonthly, or tri-annual frequency.~~

~~In addition to billing frequency, the ease of understanding a bill and the educational value of the bill are also important methods of promoting conservation, as outlined in Section 3.0, recommendation 2.~~

At the same time, pricing structures must ensure the long-term financial integrity of water utilities, enabling them to provide safe, reliable, sustainable water services into the future. When the state's water infrastructure was developed through much needed initial public investment, replacement costs were largely under-accounted for in water utility budgets, resulting in water rates that have generally not reflected the true cost of water service provision. As utilities now face the costs to maintain, replace, and, in some cases, expand the original infrastructure, most find themselves facing financial needs that exceed the revenues they are able to collect through existing rates.

Additionally, suppliers tend to collect most or all revenues on a volumetric basis (charge-per-unit-sold), but costs are often fixed, especially in the short term. Many basic infrastructure needs remain constant regardless of demand, and even where system investments can be pared back over time in response to reduced demand, those components that have long service lives cannot be easily eliminated in the near term. As a result, water conservation can exacerbate financial gaps unless rates are strategically designed to recover costs in the face of reduced demands. Finally, protecting the affordability of water for basic needs (e.g. drinking, cooking, and sanitation) remains a key social function of water utilities, even as more discretionary uses are targeted for conservation.

In short, determining water prices and rate structures is a multi-faceted task that must simultaneously support several underlying goals. Fortunately, research, guidance, and rate design tools have substantially advanced in recent years, addressing these complexities. The standards and recommendations in this chapter reflect these advances and are intended collectively to support the development and adoption of water prices and rate structures that encourage water use efficiency and conservation, *as they*:

- Ensure the long-term sustainability of water supplies through appropriate cost recovery,
- Promote equitable distribution of costs among rate payers, and
- Protect affordability of water for essential needs.

The chapter also reflects increasing recognition of the importance of engaging rate payers and political leaders alike in rethinking water pricing. Establishing rates that promote conservation in an effective balance with multiple goals requires ensuring that community members understand their water supply system's challenges and costs, as well as its critical role in supporting public health, safety, and economic development.

The standards and recommendations describe key principles and points of guidance, while the resources listed at the end of the chapter comprise more comprehensive guidance and specialized rate-setting tools.

4.1 Standards

1. ~~Use~~**Recover the Full ~~-~~Cost ~~Pricing~~. ~~Establish a~~of Water Service**. Communities and water suppliers should establish pricing ~~structure~~and revenue structures that ~~includes~~recover the full cost of operating, maintaining, and protecting the water supply system~~. Perform a~~, and perform annual rate ~~evaluation every three to five years~~evaluations to adjust ~~costs~~prices as needed.

   Full ~~-~~cost ~~pricing factors all costs including operations, maintenance, capital, and indirect costs (such as environmental impacts, watershed protection, and revenue stabilization) into prices. Full cost pricing~~recovery can ~~take the~~ be achieved with any form of ~~any~~ rate structure~~ so~~, as long as all costs are recovered~~ through prices. A full cost water pricing structure includes, but is not limited to, the following:~~, including primary costs (e.g. operations and capital expenses) and supporting costs (e.g. watershed protection and public education). Full cost recovery should ensure, at a minimum, recovery of the following costs, as applicable to each system:

   - Pumping equipment and distribution system operation, repair, and maintenance;
   - Water treatment;
   - Electricity and energy costs;
   - Capital investments, including planning, design, and construction;
   - Watershed land purchase/protection, well site purchase/protection, aquifer land purchase/protection;
   - Debt service;
   - Administration (including personnel and systems management, billing/accounting, customer service, cost of service studies, rate analyses, and long-range planning efforts);
   - A water conservation program that could include some or all of the following:
     - ~~Purchase and installation of water conservation/retrofit devices and rebate programs to promote their adoption in the service community;~~

Water audits~~;~~ (utility audits and individual facility audits,

     - ~~**All** aspects of a public education program~~ including ~~purchase and distribution of educational materials and related staff time;~~voluntary customer audits);
     - Leak detection equipment, services, and repair;
     - ~~Metering and billing, including a meter~~Meter replacement/repair program; ~~and~~
     - Automated meter reading equipment, including installation and maintenance~~.~~;
     - ~~Hiring staff to run all aspects~~Purchase of ~~the~~ water ~~supply system, staff~~conservation devices offered for free or at subsidized costs to customers (such as low-flow faucet devices and toilet leak-detection kits);
     - Customer rebate programs for water efficient fixtures and appliances and/or rainwater collection systems;

- A public education program including, for example, educational components of water bills, school partnership programs, and public workshops;

- Regulatory compliance, including mitigation of environmental impacts, permitting, and reporting expenses; and
- Staff salaries, benefits ~~package, and staff~~, training, and professional development~~;~~.

- ~~Pumping, maintenance, electricity/fuel;~~
- ~~Treatment and associated treatment plant costs;~~
- ~~Distribution system operation, repair, and maintenance;~~
- ~~Watershed land purchase/protection, well site purchase/protection, aquifer land purchase/protection, stormwater recharge plan;~~
- ~~A capital replacement fund, capital depreciation account, and debt service; and~~
- ~~A rate stabilization fund to moderate potential fluctuations in revenue associated with fluctuations in consumer demand.~~

~~2. **Prohibit decreasing block rates**. Decreasing block rates that charge lower prices as water use increases during the billing period, are **not allowed** by M.G.L. Chapter 40, Section 39L. Although this law does not cover private companies that are regulated by the Department of Public Utilities, private water companies are governed by a memorandum of understanding (dated December 29, 1998) between the DPU and MassDEP. MassDEP will include a provision requiring the filing of a rate adjustment application with DPU in any permit issued to a private company. This rate adjustment application shall propose either a flat or increasing block rate structure. DPU must then consider the application and issue a determination directing the company to implement either a flat or increasing rate structure unless the company has adequately supported reasons why this should not occur. Although flat fee systems and uniform rates are allowed, increasing block or seasonal rate structures are preferred (see recommendation 1 below).~~

2. **Do not use decreasing block rates**. Decreasing block rates that charge lower prices as water use increases during the billing period should not be used. For water utilities operated by public entities[19], decreasing block rates are prohibited by Massachusetts General Law Chapter 40, Section 39L.

4.2 Recommendations

1. **Use Price Signals to Reduce Inefficient and Nonessential Use.** Communities and water suppliers should adopt rate structures that encourage efficiency in essential[20] water use and reduction of nonessential[21] water use.

   One way this can be achieved is by setting uniformly high water rates. Such an approach is conceptually and administratively simple; however, it may present affordability concerns for customers even when they are using water efficiently.

   An alternative approach used more frequently targets inefficient and nonessential uses with higher per-unit charges. These types of structure are referred to as *conservation-oriented rates*, and they can be

[19] Except those in Hamden County

[20] Essential uses are defined by MassDEP as uses required: a) for health or safety reasons; b) by regulation; c) for the production of food and fiber; d) for the maintenance of livestock; or e) to meet the core functions of a business.

[21] Nonessential uses are those *other than* essential uses.

customized in a number of ways to fit a particular community and system and to be compatible with full-cost recovery. To be effective, a conservation-oriented rate should demonstrate: a) a mechanism that reasonably distinguishes water being used efficiently for essential purposes from water being used excessively, for discretionary purposes, or at times that place a particularly high burden on the system or environment; *and* b) a meaningful increase in unit price between the former and the latter. Examples – which can be combined and are not mutually exclusive – include, but are not limited to:

- Seasonal Rates – unit charges increase to reflect seasonal peak demands and/or seasonal source stressors, such as naturally low flows
- Tiered Rates – unit charges increase as a customer's usage crosses set volume thresholds within a billing period

  Note that simple increasing blocks, in which tiers are applied identically across a customer base, can promote conservation if structured appropriately and applied to a fairly homogeneous customer base. More tailored or customized tiers account for differences in customer type, such as single-family vs. multi-family units, household size (*budget-based* tiers), or other distinguishing factors. Such rates are more data and resource-intensive[22], but have been shown to be more effective at conservation, and generally more equitable, than simple increasing block rates.[23]
- Drought or Scarcity Rates (unit charges increase based on drought triggers or other specific indicators of source stress, such as deteriorating water quality or decline in reservoir levels caused by increasing demands).

2. **Establish an Enterprise Fund.** Municipalities that operate as public water suppliers should establish an enterprise fund in accordance with Massachusetts General Law Chapter 44, Section 53F 1/2, or equivalent, to segregate water supply accounting from the municipal general fund and other governmental activities. Such a fund allows the water supplier to account for the total costs of operating and maintaining the water supply system and ensures all revenues derived from water supply activities are retained for, and applied to, water supply expenditures.

3. **Engage in Long-term Planning and Budgeting.** It is recommended that water suppliers develop a long-term operating and capital improvement plan as the basis for establishing water rates and annual budgets. A planning horizon of ten or more years can help the water supplier: 1) educate customers and decision makers about the financial needs of the water supply system; 2) build in revenue streams to cover high-cost capital items; 3) provide justification for debt acquisition; and 4) avoid high costs of deferred maintenance by anticipating and budgeting for timely infrastructure repair activities.

4. **Customize Rate Structures to Address Revenue Stability, Affordability, and Equity**. Through customization of a variety of rate structure approaches, and through use of increasingly advanced rate-setting tools and resources, suppliers are encouraged to set rate structures that not only recover all costs and send conservation price signals, as described above, but that seek to:
   - Stabilize revenue streams;
   - Protect affordability for efficient, essential uses; and

[22] To reduce the administrative burden of determining every household size, some suppliers implement budget based tiers by assigning tiers to all residential customers that presume a given household size (such as 4 people) and allow larger households to apply for adjusted tiers based on actual household size.

[23] Wang et al., American Water Works Association (2005). *Water Conservation-Oriented Rates: Strategies to Extend Supply, Promote Equity, and Meet Minimum Flow Levels*.

- Distribute costs fairly and equitably.

Strategies to help stabilize revenue include, for example, maintaining a reserve fund and/or increasing fixed charges as a component of customer bills. Note that rate structures that include fixed charges can still send strong conservation signals by incorporating steep per-unit price increases for discretionary or excessive use. To ensure conservation signals are not weakened when fixed charges are increased or newly introduced, the volumetric portion of rates should be simultaneously re-evaluated and adjusted as needed.

Protecting affordability can be achieved, for example, by employing discount rates for customers qualifying on the basis of income. Some suppliers address affordability by setting low (subsidized) per-unit charges across the full customer base for the first tier of use, intended to cover efficient water use for essential needs, although this approach can make full cost recovery more challenging.

Mechanisms to distribute costs equitably might include allocating charges that reflect relative burdens on the system, such as fire protection charges based on infrastructure costs across the service territory, peak usage charges that apply during times when supplemental sources or treatment facilities are used to meet peak demands, or steep excess use charges for the highest exceedances over allotted volume to help recover (or better yet, ward off) costs associated with acquiring new sources.

Resources listed at the end of the chapter provide additional guidance on these and many other strategies to address the above goals.

5. **Use Billing Practices that Support Price Signals.** Price signals are most effective when customers: a) understand the rates and the impact of their usage patterns on their bill; and b) receive bills frequently enough to respond in a relevant timeframe by adjusting their water use or investigating potential sources of water loss. It is recommended that suppliers adopt the following billing strategies that have been shown to increase the effectiveness of conservation price signals, recognizing that constraints in billing software and meter reading may require some of these practices to be phased in over time, as equipment and technology are updated:
   - **Bill monthly (or at a minimum bi-monthly)**. This is particularly important in encouraging improved efficiencies or reductions in landscape irrigation and other seasonal discretionary uses and in identifying and repairing leaks in a timely fashion.
   - **Use gallons as a billing unit.** This assists customers in visualizing their usage volumes in familiar terms and making adjustments that may meaningfully impact their rates.
   - **Include educational components in bills.** Clear, education-oriented bills can help customers understand the rates, track their usage in relevant ways, and recognize the financial and environmental benefits of conserving water. Specific suggestions for improving the educational value of water bills can be found in Chapter 3, Metering. (Note that automatic bill payment systems can provide substantial convenience for customers, but may reduce customers' exposure to targeted price signals and key messages about their water use. Suppliers who offer the convenience of auto-pay billing should consider supplemental communications to ensure delivery of information specific to customers' usage and related educational messages.)
6. **Engage in Positive Messaging.** As the pricing and rate approaches outlined above may represent a departure from what customers have become accustomed to, suppliers, community leaders, and state policy makers are encouraged to proactively engage in messaging campaigns to help rate payers:

- Recognize the value of reliable access to clean water for public health, safety, and the economy;
- Understand the drivers of water utility costs (which may involve emphasizing that utilities maintain a safe and reliable water supply *system* in addition to delivering a *commodity*);
- Appreciate the environmental and financial benefits of water conservation;
- Appreciate the importance of long-range planning for water supply sustainability.

Chapter 10, Public Education and Outreach, includes some useful strategies for communicating with the public.

7. **Engage the Public in Rate Making.** Public conversations and engagement can make a critical difference in setting effective water rates that rate payers and community decision-makers will understand and support, especially if substantial rate restructuring is needed. The resources listed at the end of the chapter provide some useful guidance for planning and structuring public engagement. Additional useful suggestions can be found in Chapter 10, Public Education and Outreach. Some key points of guidance include:
   - Incorporate broad community representation; vehicles such as mailed surveys and well-balanced advisory committees can help ensure inclusion of all perspectives.
   - Data can be a powerful engagement tool; for example, modeling the impact of various rate structures on different user groups can help the public evaluate trade-offs and hone in on solutions that fit the community's needs.
   - While the initial groundwork for setting up public engagement structures can be resource-intensive, once developed, these structures can be used repeatedly to evaluate progress, make necessary course corrections, or engage on newly emerging issues.

4.3 Resources

While the standards and recommendations above set broad guidelines, the following resources, which include more comprehensive information and advanced rate-setting tools, are provided to assist in implementation.

- American Water Works Association (2017). *Manual of Water Supply Practice M1 Principles of Water Rates, Fees and Charges 7th, edition* (or most recent edition).
  Available at: https://www.awwa.org/store/productdetail.aspx?productid=61556627
- American Water Works Association (2017). *Manual of Water Supply Practice M54Developing Rates for Small Systems, 2nd edition* (or most recent edition).
  Available at: https://www.awwa.org/store/productdetail.aspx?productid=43980741
- Alliance for Water Efficiency (2014). Handbook: *Building Better Water Rates for an Uncertain World: Balancing Revenue Management, Resource Efficiency, and Fiscal Sustainability;* and downloadable software tool and user guide: *AWE Sales Forecasting and Rate Model* and *Rate Model User Guide*.
  Available at: http://www.financingsustainablewater.org/tools/building-better-water-rates-uncertain-world
- Wang et al., American Water Works Association (2005). *Water Conservation-Oriented Rates: Strategies to Extend Supply, Promote Equity, and Meet Minimum Flow Levels*.
  Available at: https://www.awwa.org/store/productdetail.aspx?productid=6544

~~1. U.S. EPA Rate Structuring – To promote water conservation, communities and water suppliers should consider rate structures that encourage efficiency in essential water use and reduction of nonessential water use. Generally nonessential uses are defined as those activities not required: (a) for health or safety reasons; (b) by regulation; (c) for agricultural production; (d) for the maintenance of livestock; or (e) to meet the core functions of a business. Communities and water suppliers should avoid flat fee rates,[24] and uniform rate structures[25] that are set too low to encourage conservation. These rate structures do not discriminate between essential and non-essential water use, and do little to encourage conservation. Those with responsibility for setting rates must consider the impact of adopting seasonal and increasing block rates on those uses that may fall into one of the above categories. It may be more appropriate to develop a separate rate category for other classes of uses (i.e., "essential"), which takes into account the legitimate essential water uses, but still provides for water conservation.~~

~~The following rate structures may be appropriate to reduce nonessential water use:~~

- ~~Increasing block rates. Increasing block rates or tiered pricing encourages reduced water use by increasing the per-unit charges for water as the amount used increases. For residential rates, the first block should be based on a volume of water that represents efficient indoor water use by an average household, the next block is charged at a higher rate, and so forth. The price difference between blocks and the number of gallons included in each block are very important in influencing the customer's use behavior. If the difference in cost between blocks is too small, or the number of gallons included in each block is too large, it will not provide the incentive to conserve at the higher block rate.~~
- ~~Seasonal rates. Seasonal rates are set according to water demands and climate conditions. There are a variety of approaches to develop conservation-oriented rates including increasing block rates only~~

~~[24] Flat fee rates do not vary by customer characteristics or water use.~~

~~[25] A uniform rate charges the same price per unit for water use beyond the fixed customer charge, which covers some fixed costs. If uniform rates are high enough, they can encourage conservation although not as effectively as an increasing block rate.~~

during the summer months (May 1 to September 30 when demand is often higher) or a year round inclining block rate structure with higher block rates during the summer months.[26]

2. Enterprise Accounts – It is recommended that the water supplier establish an enterprise account for water in accordance with Massachusetts General Law, Chapter 44, Section 53F 1/2 Enterprise Funds.

3. Develop a Methodology to Assess Environmental Costs – EEA should commit to developing a methodology for assessing the environmental costs of water withdrawals for water suppliers to use in setting true "full cost" water prices.

[26] For more information on developing conservation-oriented rates, see:

- "Water Conservation-Oriented Rates: Strategies to Extend Supply, Promote Equity, and Meet Minimum Flow Levels" (Wang et al., American Water Works Association, 2005)
- New England Water Works Association.2009. Best Management Practice – Conservation Pricing: Rate Setting, Metering, and Billing Considerations to Encourage Water Conservation. May 29, 2009. Available at http://www.newwa.org/Media/waterUtilityNews.htm
- The US EPA homepage on Water and Wastewater Pricing: http://water.epa.gov/infrastructure/sustain/financing_priceofwater.cfm
- "Water and Wastewater Pricing, An Informational Overview" (US EPA Office of Water and Wastewater Management EPA 832-F-03-027) - http://www.epa.gov/owm/waterinfrastructure/pricing/pdfs/waterpricing_final2.pdf
- American Water Works Association,: M1 Principles of Water Rates, Fees and Charges 5th, edition (2000).

- Water and Wastewater Pricing Resources (manuals, tools, publications, case studies): https://www.epa.gov/sustainable-water-infrastructure/pricing-and-affordability-water-services
- Beecher, J.A. and T. Chesnutt, Alliance for Water Efficiency (2012). "Declining Water Sales and Utility Revenues: A Framework for Understanding and Adapting". Available at: http://www.allianceforwaterefficiency.org/uploadedFiles/Resource_Center/Library/rates/Summit-Summary-and-Declining-Water-Sales-and-Utility-Revenues-2012-12-16.pdf
- American Water Works Association (2013). *AWWA G480-13 Standard: Water Conservation Program Operation and Management*. Available at: https://www.awwa.org/store/productdetail.aspx?productid=36141161
- MA Clean Water Trust Best Management Practices: Full Cost Pricing: http://www.mass.gov/treasury/docs/mwpat/inthenews/full-cost-pricing.pdf
- MA Clean Water Trust Best Management Practices: Enterprise Funds: http://www.mass.gov/treasury/docs/mwpat/inthenews/entereprise-fund.pdf

5.0 Residential Water Use

This chapter applies primarily to:

- *Residential consumers*
- ~~*Institutional and commercial facilities*~~
- *Water suppliers*
- ~~*Water distributors*~~
- *Municipal ~~governing bodies,~~ boards~~,~~ and departments*
- *State facilities personnel*
- ~~*State policy and regulatory entities*~~
- *State policy and regulatory entities*

Over ~~fifty-five~~sixty-seven percent of the metered public water supply in Massachusetts is used for residential purposes.[27] ~~So~~Therefore, any improvements in residential water efficiency will result in significant water savings. Residential water use consists of indoor and outdoor water use. Indoor use typically includes toilets, clothes washers, showers, faucets, dishwashers, and other domestic uses including cleaning and cooking~~.~~ ~~National average indoor water use for a nonconserving and a fully conserving single-family home in North America are presented in Appendix D, Table 1, and residential water use data and benchmarks are provided in Appendix E. Outdoor water use can include~~ (Figure 5-1).[28] Outdoor water use includes irrigation of lawns and gardens, filling and refilling swimming pools, car washing, and other cleaning. Leakage within the consumer-owned portion of the water system can be an additional and sometimes substantial component of indoor and outdoor water use.

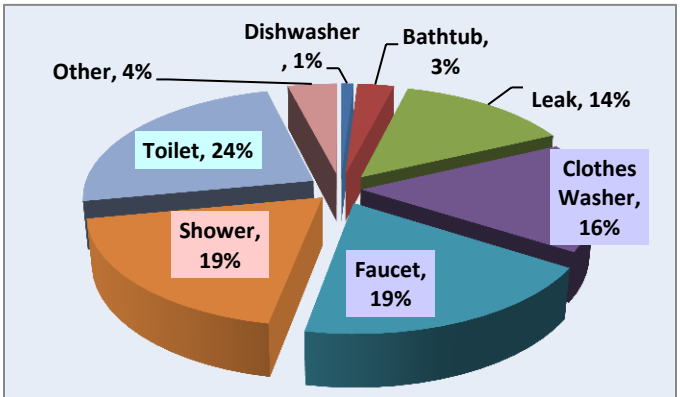


Figure 5-1. Daily household indoor water use (%) (737 homes, nationwide)

Data based on Residential End Uses of Water, Version 2. (DeOreo et al. 2016)

Higher Efficiency through WaterSense. In order to better educate the public and promote the use of water-efficient fixtures, the Massachusetts Water Resources Commission has partnered with the Environmental Protection Agency's WaterSense program and recommends that others do too. WaterSense-labeled products and services are certified to meet the program's rigorous water efficiency, performance, and testing requirements. Certified products must be at least **twenty percent more efficient** than standard products, while offering equivalent or superior performance.

WaterSense has certified products in seven categories: tank-type and flushometer-valve toilets, flushing urinals, bathroom (lavatory) faucets, showerheads, irrigation controllers, commercial pre-rinse spray valves, and new homes. The program also provides a label for certification programs for landscape irrigation professionals. More than 21,000 products carry the WaterSense label, and the program continues to certify

[27] Based on MassDEP analysis of ~~ASR~~Annual Statistical Report data for ~~2009~~2011 and ~~2010, fifty-five percent of~~2012 on water ~~that entered distribution systems was~~ metered ~~as residential.~~through service connections.

[28] DeOreo, W., P. Mayer, B. Dziegielewski, and J. Kiefer. 2016. Residential end uses of water, version 2. Denver: Water Research Foundation.

new products and categories of products.[29] For the latest updates, see the WaterSense program website at http://www.epa.gov/watersense/.

[29] The numbers of WaterSense-labeled models and categories of products are current as of 2016.

5.1 Standards

~~Additional standards for~~ Standards specific to outdoor residential water use ~~related to lawns and landscapes are~~ are presented in ~~Section~~Chapter 9~~.0 Lawn and Landscape~~, Outdoor Water Use.

1. ~~**Install Water Efficient Plumbing Fixtures**. For plumbing fixtures installed prior to 1989, meet the standards set forth in the Federal Energy Policy Act, 1992 (or most recent version) and the Massachusetts Plumbing Code (Appendix D, Table 2). Include low-flow showerheads, faucet aerators, low-flow toilets (1.6 gpf), or high efficiency toilets (HETs) (1.28 gpf or less).[30] Provide and promote toilet leak detection kits, and educational literature about installation of water saving devices and water conservation savings (in gallons and dollars) in retrofit programs.~~

Water Users:

1. **Use Residential Water Efficiently.** ~~Meet or demonstrate steady progress toward meeting~~[31]Keep year-round residential water use ~~of 65 gallons per capita per day (gpcd),~~ including both indoor and outdoor use, ~~as soon as practicable, especially in those~~to 65 gallons per capita per day (gpcd) or less.[32] During periods of drought or water system stress, communities ~~in a basin with~~ may find an even lower target is needed.

Ten Steps to a Comprehensive Water Conservation Program (Vickers, 2001)[23]

1. **Establish water-reduction goals**
2. **Develop water-use profile & forecast**
3. **Evaluate planned water & wastewater facilities**
4. **Identify & evaluate conservation measures**
5. **Identify & assess conservation incentives**
6. **Analyze benefits & costs**
7. **Select conservation measures & incentives**
8. **Prepare & implement the Conservation Plan**
9. **Integrate conservation & supply plans, modify forecasts**
10. **Monitor, evaluate, & revise program as needed**

~~[30] Manufacturers continue to improve fixture efficiency. As of 2012, 68 manufacturers offer 550 models of single-flush high-efficiency toilets (1.28 gallons per flush or less). See EPA's WaterSense program for product evaluations and guidelines on selecting the most efficient fixtures.~~

~~[31] The Commonwealth recognizes the existence of circumstances that could affect a community's efforts to fully meet this standard. These circumstances could include aging residential infrastructure and large seasonal population fluctuations. In such cases, the community should document, as part of its regulatory requirements, all efforts that have been undertaken in order to comply with this standard.~~

[32] To convert household use to per person use, see the Gallons Per Capita Daily Lookup Table in Appendix C.

Communities and Water Suppliers:

~~1.~~2. **Meet the residential performance standard of 65 gpcd**.[33] The residential performance standard of 65 gpcd is a ~~higher~~ system-wide average that represents a minimum level of ~~stress.~~[34] ~~The WRC will periodically monitor the state-wide progress of communities using~~efficiency, based on information ~~provided in the ASR water audit.~~ in Appendices D and E.[35] If local environmental or operational conditions warrant higher efficiency (such as during times of drought), strive to achieve year-round residential water use of less than 65 gpcd.

~~2.~~3. **Implement a comprehensive residential water conservation program** that seeks to reduce residential water use by implementing ~~some or all of the~~ applicable recommendations ~~listed~~ in this ~~section~~chapter and by meeting the standards ~~in Section 9.0~~ on ~~Lawn~~Outdoor Water Use (Chapter 9) and ~~Landscape.~~Public Education and Outreach (Chapter 10). The scope of the program will be specific to circumstances in each community, and the ~~recommendations~~recommendations listed below ~~are provided as~~provide a menu of options. If a community's water consumption is at or below 65 gpcd, that community should continue with efforts to remain at that level or ~~improve~~reduce residential per capita water use.[36]

[33] The commonwealth recognizes the existence of circumstances, including large seasonal population fluctuations, that could affect a community's efforts to fully meet this standard. In such cases, the community should document all efforts that have been undertaken to comply with this standard.

~~[34] Basin stress as defined by the Water Resources Commission. See WRC publication 'Stressed Basins in Massachusetts, December, 2001' or most recent version.~~

[35] See Appendix D, Figure D-1, for national average indoor water use for single-family homes in North America. See Appendix E for residential water-use data and benchmarks.

[36] Vickers, Amy. 2001. *Handbook of water use and conservation.* Amherst, MA: WaterPlow Press. See Chapter 1 for details.

5.2 Recommendations

The following recommendations apply to indoor water use. Standards and ~~outdoor water use that is not related to lawn and landscape maintenance. Recommendations~~recommendations for outdoor residential water use ~~related to lawns and landscapes~~ are presented in ~~Section~~Chapter 9~~.0 Lawn and Landscape. Promote~~, Outdoor Water ~~Efficient Household Appliances Water Efficient Household Appliances (especially clothes washers) provide an opportunity for significant water (and energy) savings (Appendix D, Table 1). In most communities, indoor water use constitutes the majority of water used, even in summer. State and municipal officials should take the lead with professional organizations in implementing the following six strategies to achieve this recommendation~~ Use.

All Water Users:

1. **Choose high-efficiency plumbing products and appliances.** Look for the WaterSense label on plumbing products and the Energy Star label on appliances to find products that meet high standards for efficiency and performance. See Appendix D, Table D-2, for efficiency standards. Significant water and energy savings can be achieved by choosing high-efficiency residential products such as the following:

   a. High-efficiency toilets (HETs): Toilets account for twenty-four percent of indoor water use, the highest percentage of all indoor residential uses (see Figure 5-1). HETs use 1.28 gallons per flush (gpf) or less, or twenty percent less than conventional "low-flow" models (which use 1.6 gpf). Dual-flush models (averaging 1.28 gpf) and power-flush models (using as little as 0.8 gpf) are also available. Performance testing indicates that many HETs provide equal or greater flushing power than conventional toilets[37].

   b. High-efficiency clothes washers (HEWs): Clothes washers account for sixteen percent of residential indoor use (see Figure 5-1). Water efficiency in clothes washers is indicated by the Integrated Water Factor (IWF)[38]. A lower IWF indicates a more water-efficient clothes washer. Efficiency varies depending on the capacity (compact or standard) and configuration (front-loader or top-loader) of the clothes washer. Generally, front-loaders are more efficient, though the efficiency of top-loaders is improving.[39] For the greatest efficiency in both water and energy use, select products identified as CEE Tier 3 by the Consortium for Energy Efficiency[40] or Energy Star-labeled products.[41]

2. **Fix leaks as soon as possible.** Dripping faucets and leaking toilets, pipes, and appliances can add up to hundreds of gallons of water lost per week, representing dollars down the drain. For guidance on finding and fixing common leaks, see "Don't Waste a Drop: Finding, Fixing and Preventing Indoor Water Leaks" at http://www.ose.state.nm.us/FixALeak/add_info.php.[42]

[37] http://www.map-testing.com/

[38] For clothes washers, the next federal compliance date for more stringent energy and water efficiency standards is January 1, 2018. See 10 CFR 430.32(g)(4).

[39] Appliance Standards Awareness Project. Clothes Washers. Available at http://www.appliance-standards.org/product/clothes-washers (accessed January 20, 2017).

[40] See the Qualifying Products lists developed by the Consortium for Energy Efficiency (at http://library.cee1.org/content/qualifying-product-lists-residential-clothes-washers and http://library.cee1.org/content/qualifying-product-lists-residential-dishwashers).

[41] For the greatest efficiency, look for products listed as "Energy Star Most Efficient" (at www.energystar.gov/).

[42] Water Use and Conservation Bureau. New Mexico Office of the State Engineer. February 2002 (http://www.ose.state.nm.us/FixALeak/add_info.php).

3. **Reduce water use (and improve septic system function where applicable) by not running water continuously at sinks.** For kitchen waste, divert compostable waste to a compost pile instead of using a garbage disposal. Finished compost then can be added to the soil around the home or spread thinly on the lawn to boost its soil-moisture-retention capacity and reduce the need for watering.

Water suppliers, municipal officials, and state facilities managers:

4. **Promote the use of high-efficiency plumbing fixtures and appliances in retrofits and new construction** (see Recommendation 1 above).

   - ~~**Update the State Plumbing Code.** The State should include efficiency standards for household appliances in the plumbing code and should update existing plumbing fixture standards to reflect current designs that allow for greater water use efficiency.~~
   - ~~Create tax incentives for installation of water efficient appliances. The State should investigate opportunities to provide a sales tax exemption on the purchase of qualified water efficient toilets and washing machines.~~

5. **Offer rebates for replacing inefficient fixtures and appliances.** ~~Communities with older housing stock should consider the costs/benefits of~~Consider implementing a wide-ranging program to replace older, high-water-use toilets and other fixtures and appliances through retrofit~~/~~ and rebate programs ~~as described above.~~.

6. **Consider providing free or low-cost water audits to residential customers.** Analyze winter water-use data to identify customers who would benefit from an audit. A residential water audit should include the following components at a minimum[43]:

   - Indoors: Inspect toilets, showers, faucets, clothes washers, dishwashers, water filters, water softeners, evaporative coolers, spa/hot tub, and other fixtures or appliances for leaks, flow rate, presence of water-saving retrofit devices, and efficient use of fixtures and appliances by residents.
   - Outdoors: Evaluate outdoor water uses for efficient operation and leaks. See Chapter 9, Outdoor Water ~~suppliers~~Use, and Appendix I: Guidelines for Efficient Irrigation.
   - Justify the investment in the recommended upgrades by conducting a payback analysis[44] that evaluates reductions in water costs.

7. **Facilitate Leak Repair** – Leaks can represent a substantial portion of indoor water use – fourteen percent of residential indoor water use (see Figure 5-1). Consider using metering technology to identify patterns of water use that indicate leakage in the customer's home. If leakage is suspected, notify the customer.[45] Communities should consider offering assistance or providing an incentive for customers to fix leaks that they might otherwise allow to run continuously. For leakage in service connections, see Chapter 2, Water Loss Control (Recommendation 3).

[43] For guidance, see "Residential Water Audits" in the series "Best Management Practice: Water Conservation." Available from the New England Water Works Association at http://www.newwa.org/MembershipResources/UtilityResources.aspx#96523-bmps-and-advisories. Sample worksheets for residential water audits are included in the *Handbook of Water Use and Conservation* (Vickers 2001, Appendix E (indoors) and Appendix F (outdoors)).

[44] A payback analysis calculates the amount of time needed for an upgrade to pay for itself in cost savings over time. The formula is:
Payback period = cost of upgrade / savings in water and energy costs per unit time

[45] Studies indicate that only 10% of the homes studied were responsible for 50% of leaks found. Identifying and targeting those customers for outreach is recommended. See DeOreo, W., and P. Mayer. 2012. Insights into declining single-family residential water demands. Journal – American Water Works Association. 104:E383 – E394. Available at http://dx.doi.org/10.5942/jawwa.2012.104.0080.

8. **Incorporate Alternative Technologies, where appropriate** – Those wishing to go beyond current standards and do more to conserve water should consider alternative technologies, such as composting toilets, waterless urinals, or water reuse systems. State and municipal buildings can serve as demonstration sites for these technologies, where appropriate.

"This result suggests that leakage-reduction efforts should not be targeted at the general population but at the houses in the top 10% of the group….These top 10% of the houses account for 50% of the total leakage."

DeOreo and Mayer 2012 (see note 32)

State Policy and Regulatory Entities:

9. **Update the State Plumbing Code.** ~~providing customer~~The state, through the Water Resources Commission, should work with the state Plumbing Board to update existing water-use standards for plumbing fixtures to reflect current designs that allow for greater water-use efficiency, and with the state Plumbing Board and MassDEP to review current policies and regulations related to reclaimed water and recommend changes that would remove barriers to water reuse and facilitate (with considerations for water quality) the implementation of reuse systems.

~~1.~~10. **Create incentives, including rebates, for installing water-efficient plumbing fixtures and appliances.** The state should investigate opportunities to offer rebates on water-efficient appliances through ~~the energy industry~~energy utilities, since water-efficient appliances are also typically energy efficient.

- ~~Install water-efficient fixtures and appliances in new construction. Water suppliers, water commissioners, mayors, selectmen, building and/or plumbing inspectors, and appropriate local boards or officials should work together, strongly recommending that contractors and owners install water efficient household appliances, including clothes washers, "point of use" water heaters and dishwashers, in new developments and redevelopments whenever feasible.~~

~~2.~~11. **Incorporate water conservation into MEPA review for large new developments.** EEA should work with MEPA to develop a standard set of water conservation recommendations as part of the MEPA review for large new developments and redevelopments. The recommendations should include but not be limited to the installation of water-efficient ~~household~~plumbing fixtures and appliances and meeting all appropriate standards and recommendations for lawn and landscape water conservation, as included in ~~Section~~Chapter 9 ~~Lawn and Landscape~~, Outdoor Water Use.

- ~~Promote use of high efficiency toilets (HETs).[46] Programs that include low-flow toilets should consider High Efficiency Toilets that use less than 1.28 gallons per flush, including "dual flush" toilets widely used in Europe and Australia, as well as power-flush models that use as little as 0.8 gpf and offer significant water savings over the now standard 1.6 gallon models. Performance testing indicates that many HETs provide equal or greater flushing power than conventional toilets (http://www.map-testing.com/).~~

~~2. Provide Residential Water Audits – Communities and water suppliers should consider providing free or low-cost residential water audits to customers, targeting the largest users first. A residential water audit should include the following components at a minimum:~~

- ~~Inspection of toilets, showers, faucets, clothes washers, dishwashers, water filters, water softeners, evaporative coolers, spa/hot tub, etc. for leaks, flow rate, presence of water-saving retrofit devices, and efficient use of fixtures and appliances by residents. Audits should include a payback analysis showing homeowners how reductions in water costs justify the investment in the recommended upgrades. A sample worksheet for residential water audits is included in the Handbook of Water Use and Conservation (Vickers 2001).~~

~~3. Promote Efficient Non-Landscape Outdoor Water Use – The State, communities, water suppliers, and other applicable public/private/nonprofit organizations should promote efficient outdoor residential water use by educating consumers to adopt simple but effective practices such as the following:~~

- ~~Covering swimming pools when not in use to prevent evaporative losses;~~
- ~~Sweeping driveways, walks and decks with a broom rather than hosing them off; and~~
- ~~Washing vehicles using a bucket and sponge, employing a hose for rinse only.~~

~~[46] http://www.cuwcc.org/resource-center/products/toilet-fixtures-main.aspx http://www.map-testing.com/~~

4. Promote Efficient Lawn and Landscape Water Use – See Section 9.0 for lawn and landscape standards and recommendations.

5. Promote Waterless Plumbing Fixtures – Communities, water suppliers, developers and individuals wishing to go beyond current standards and do more to conserve water should consider installing waterless plumbing fixtures such as a composting toilet or 3-ounce foam flush toilet, which can be flushed with only 6 ounces of a soapy solution (3 ounce pre-flush and 3 ounce post flush). State and municipal buildings should be used as demonstration sites for these technologies.

6. Minimize/Discourage Use of Garbage Disposals – Encourage consumers to reduce the use of sink garbage disposals to improve septic system function (where applicable) and save water. Divert compostable waste to a compost pile instead. Finished compost then can be added to the soil around the home or even spread thinly on the lawn to help boost its soil moisture retention capacity and reduce the need for watering.

7. Educate Homeowners about how Water Conservation benefits Water Quality – Water conservation helps septic systems work better and last longer, and in sewered communities reduces the burden on wastewater treatment facilities, augmenting the return on investment in water-conserving fixtures and appliances.

8. Facilitate Leak Repair – Communities should create a list of plumbers that would be willing to fix a leak at a reasonable rate, and provide this list to the public, to provide an incentive for people to fix leaks that they might otherwise allow to run continuously.

9. During site design, incorporate Low Impact Development (LID) techniques that preserve or restore a site's natural hydrology, and use low water use/drought resistant landscaping techniques, to the maximum extent practicable.

~~This page intentionally left blank~~

12. **Periodically monitor the state-wide progress of communities in meeting water conservation standards using information provided in the Annual Statistical Report.**

5.3 Resources

- Alliance for Water Efficiency. Home Water Works Calculator. Available at http://www.home-water-works.org/
- EPA WaterSense. Detailed specifications for WaterSense-labeled products can be found at http://www.epa.gov/watersense/.
- EPA Energy Star. Product specifications for water-using appliances available at http://www.energystar.gov/products/spec/.

5.4 Related Appendices

- Appendix D, Improvements in Household Water Efficiency and Standards
- Appendix E, Residential Water-Use Data and Benchmarks
- Appendix I, Guidelines for Efficient Irrigation

6.0 Public Sector

This chapter applies primarily to:

- *Municipal ~~governing~~ bodies, boards, and departments*
- *Municipal facilities and public works personnel*
- *State facilities personnel*
- *Private and nonprofit organizations*
- *State policy and regulatory entities*

Municipal and state buildings, facilities, and landscapes should be at the forefront on indoor and outdoor water use efficiency. They should set an example and lead the way in water conservation, water-saving techniques, and concepts. These sites should serve as demonstration sites with signage to make the public aware that the state and municipalities are leaders in water conservation. The following standards and recommendations will help emphasize and implement water conservation and efficiency in government buildings, facilities, and landscapes. They will also help to accurately account for water use and serve as demonstrations of water saving techniques and concepts to the public. ~~Appendix L highlights features of municipal water conservation programs in Massachusetts.~~

6.1 Standards

1. Municipal and state buildings
   - **Conduct indoor and outdoor audits** and account for full use of water, based on full metering of public buildings, parks, irrigated playing fields, and other facilities.
   - **Analyze existing water-use data** to spot trends, patterns, and unexplained increases that could indicate leaks or inefficient use of water.
   - **Identify** measures where the **greatest efficiencies** and potential savings can be realized.
   - Build new public buildings with **equipment that reduces water use**, such as faucet aerators, low-flow showerheads, composting or high-efficiency toilets (HETs) (or "dual-flush" models),[47] and self-closing faucets. Water-saving devices and measures should be well identified to users of public buildings and facilities.
   - **Focus on replacing/retrofitting** water-consuming equipment in buildings (e.g. bathrooms, boilers, chillers).
   - **Practice good, efficient lawn and landscape water-use** techniques and meet the standards as described in ~~Section~~Chapter 9.0 on Outdoor Water use.
2. **Meter or estimate contractor use of water** from fire hydrants for pipe flushing and construction.
3. **Strictly apply plumbing codes** and incorporate other conservation measures in new and renovated buildings.

6.2 Recommendations

1. Outdoor Water Use – **Adopt outdoor water-use strategies** as per recommendations in ~~Section~~Chapter 9.0 ~~on Lawn and Landscape~~.
2. **Create Demonstration Sites** – Use public buildings as demonstration sites for innovative water conservation techniques such as composting, foam-flush and dual-flush toilets, cisterns for rain collection, and water-wise landscaping.

[47] High-efficiency toilets (HETs) have an effective flush volume of 1.28 gallons per flush or less.

~~This page intentionally left blank~~

7.0 Industrial, Commercial, and Institutional (ICI)

This chapter applies primarily to:

- *Commercial facilities*
- *Industrial facilities*
- *Institutional facilities*
- *Municipal facilities*
- *State facilities*

Water is crucial for the functioning of industrial, commercial, and institutional (ICI) facilities (including hospitals, schools, prisons, universities, and colleges). It may be used for heating, cooling, and processing, and includes an appreciable sanitary and landscaping component. In many communities, ICI facilities can use more gallons per day than any other individual water user. Instituting water conservation measures will help reduce the overall community water use significantly and result in appreciable monetary savings. The measures must be tailored to reflect the type of water use and characteristics of individual facilities (see Appendix F for BMPs). They can be built into an industry's strategy to comply with local sewer and National Pollutant Discharge Elimination System (NPDES) discharge requirements. The following standards and recommendations increase the efficiency of water use through use of best available technologies.

7.1 Standards

1. **Carry out a water audit** to determine the location and amount of water used for heating, cooling, processing, sanitary use, and outdoor use (see Appendix ~~H~~G for sample ICI water audit). Use the findings from the audit as the basis for actions to conserve water such as:
   - Recycling and reusing cooling waters to achieve greatest water-use efficiency~~/closed loop cooling~~ (cycles of concentration). Consider switching evaporative to dry cooling in cooler weather.
   - Reuse of process waters sequentially in applications on-site with lower quality requirements.
   - Using non-potable water (in conformance with the plumbing code and MassDEP regulations[48] to assure safe drinking water and to avoid cross-connections).
   - Using heat-sensitive controls and valves ~~to control~~with cooling equipment.
   - Replacing water cooling with air cooling (where ~~possible~~feasible within air quality standards).
   - Installing or retrofitting efficient sanitary water devices, performing scheduled meter maintenance and calibration, and ~~xeriscaping.~~
   - Xeriscaping.
2. Significant users (i.e. those using greater than 50,000 gpd) **install separate meters for process water** so that water can be accounted for and appreciated as a raw material in production and for sanitary use.
3. **Develop and implement a water savings strategy**, addressing among other items: demand management, leak detection and repair, a program of preventive maintenance, and a program of employee education.
4. In new and renovated buildings, comply with plumbing codes, **use the best available technologies for water conservation, and reuse treated wastewater** within the facility to the extent possible.
5. **Practice good lawn and landscape water-use techniques** and meet the standards described in ~~Section 9.0~~Chapter 9 of these Standards.

[48] See ~~314 CMR 20.00.~~314 CMR 20.00. Reclaimed Water Permit Program and Standards.

7.2 Recommendations

1. The EEA Office of Technical Assistance (OTA) should ~~be reinforced in its efforts~~continue to **provide technical assistance to companies and large water users** and work with industry groups and suppliers.
2. **Significant users should aim, wherever possible, to decrease their average water use by ~~at least~~ 10%**. The investment will pay back in the form of lower water, wastewater, and energy bills.
3. **All ICI users should install/retrofit water-saving sanitary devices**, including but not limited to low-flow showerheads, faucet aerators, toilet displacement devices, and low-flow or high-efficiency toilets and urinals. Guidelines on efficient products can be found on the WaterSense program website at www.epa.gov/watersense/.
4. **Industrial and commercial users should work with code officials, standards committees, state programs, manufacturers, and legislators to promote water conservation and efficient use**.
5. **Increase the amount of pervious areas on property**. ICI facilities often include large areas of impervious surfaces (building rooftops, parking lots, etc.) which offer excellent opportunities for replacement with pervious materials, installation of green roofs, porous pavement and bioretention areas in parking lots, and rainwater harvesting. Rainwater harvesting can serve as a supplemental water supply source and can infiltrate clean runoff into the ground where it can replenish aquifers and streamflow.
6. See ~~Section~~Chapter 9~~.0~~ for lawn and landscape recommendations.

7.3 Resources

- EPA WaterSense. October 2012. WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities. Available at https://www.epa.gov/watersense/best-management-practices.

8.0 Agricultural Water Use

This chapter applies primarily to:

- *Agricultural and horticultural entities*
- *State policy and regulatory entities*

Commercial agriculture is highly water dependent and economically sensitive to water availability and quality. ~~It cannot exist without access to water.~~Water is essential to the success and livelihood of an agricultural operation, and it is in the operator's best interest to protect and maintain water resources. In Massachusetts, agricultural water users tend to be self-suppliers with wide-ranging needs for water. Water is used i) for irrigation of crops and nursery stock; ii) for harvesting of crops (cranberries); iii) as the medium for aquaculture; iv) for washing and processing of commodities; v) as a drinking source for livestock; and vi) for cleaning and cooling of animals.

Agricultural needs for water vary by type of enterprise and on a seasonal basis. Water demands are ~~also~~ site specific and, depending on the ~~type of~~ enterprise, ~~are~~ affected by multiple factors, including climate and weather, number and ~~types~~type of animals, the water-holding capacity and infiltration rate of the soil, and ~~differing~~ crop needs.

Any conservation approach to agriculture should strike an appropriate balance between both agricultural needs for water and the need to conserve water. Examples of conservation approaches ~~in agriculture~~ include proper irrigation scheduling, in both timing (daily and seasonal) and volume; control of runoff; the uniform application of water; irrigation technologies, such as drip irrigation (where appropriate) and automated irrigation systems ~~for cranberry operations~~; and the use of ~~tail water~~tailwater recovery systems for cranberry operations.

The standards ~~encourage the adoption by~~and recommendations in this chapter reflect general agricultural water conservation approaches that growers are encouraged to adopt. Agricultural water conservation practices frequently change as new technologies are developed and as efficiencies are improved. The University of Massachusetts maintains industry specific best management practices that include the most accepted water conservation technologies and practices available. Agricultural entities ~~of a conservation approach to water use that is~~should adopt practices that are environmentally and economically appropriate for their specific operation and site conditions.

8.1 Standards

1. ~~As part of the management of an agricultural operation, adopt a water conservation approach through which **water is used**~~**Use water in a planned and efficient manner with appropriate amounts and frequency to meet needs without excessive water loss**. Over-irrigating can damage crops and increase runoff, washing nutrients and minerals out of the soil and damaging soil in the long run. Establish an irrigation schedule based on the needs of the crop.

2. **When applicable, develop a soil health management system to improve the health and function of the soil**. Soils are an ecosystem that can be managed to provide nutrients for plant growth, absorb and hold rainwater for use during dryer periods, filter and buffer potential pollutants from leaving fields, serve as a firm foundation for agricultural activities, and provide habitat for soil microbes to flourish.

ENVIRONMENTAL ENHANCEMENT
Improvements on the Farm

About 70% of cranberry growers have participated in water conservation programs like the Environmental Quality Incentive Program, administered by USDA Natural Resources Conservation Services. In five years alone, growers have made conservation improvements valued at $12,500,000, chiefly in improving how water is used on the farm. This includes the installation of flumes for controlling the flow of water, installation of more efficient irrigation components, building by-pass canals, which allow water to pass around a cranberry bog system, and creating tail-water recovery ponds which allow for storage of water exiting a bog system, conserving the water to be used for irrigation.

Another program, the Agricultural Environmental Enhancement Program, run by the Massachusetts Department of Agricultural Resources, provides those farmers who are selected and pledge to make matching investments, with a reimbursement for project costs up to $25,000 to install best management practices that improve water quality or conserve water.

Since 1999, cranberry growers have received over $1.8 million dollars to match their investments. These projects help to conserve water and to maintain the high quality water vital to growing cranberries. These improvements enhance the natural environment in the region and provide a cranberry grower with new tools to manage their farm.

Adapted from "With an Eye Toward the Future: Sustainable Cranberry Growing in Massachusetts" – Cape Cod Cranberry Growers' Association - 2011

8.2 Recommendations

~~1. A Water Conservation Working Group comprised of agricultural stakeholders should be coordinated and facilitated by the Department of Agricultural Resources (DAR). The role of the working group is to identify ways to improve water efficiency in all categories of~~ Commodity specific agricultural ~~water use and facilitate water use planning and drought contingency planning by growers.~~

1. ~~Industry~~industry member associations and ~~commodity~~grower groups are encouraged to ~~develop~~continue to **maintain and promote industry-specific best management practices** that are dynamic, adaptable to new technology, and selected based upon both economic and environmental concerns.

~~2. The Agro-Environmental Technology Grant[49] program should be funded and should include funding dedicated to the development of innovative technologies for water conservation.~~

2. ~~Micro~~Where applicable, **develop and implement a conservation plan based on guidance from the Natural Resources Conservation Service (NRCS)**[50]. This plan is a written record of conservation practices for the agricultural operation that, when implemented, will help achieve the goals of protecting the environment and natural resources. As part of this, an Irrigation Water Management Plan can be developed for site-specific needs. This plan can determine the amount of water required for each irrigation cycle, including leaching needs; how to recognize and control erosion caused by irrigation; how to determine the uniformity of application; and develop how and when to perform system maintenance to assure efficient operation.

~~2.~~3. **If supplemental irrigation is needed, micro-irrigation systems, such as subsurface drip irrigation ~~(SDI)~~, should be adopted where suitable.** ~~According to the United States Department of~~

~~P), 251 Causeway Street, Boston, MA 02114. Contact: 617-626-1700. http://www.mass.gov/agr/programs/aeep/index.htm~~

- ~~Environmental Quality Incentives Program (EQIP), USDA Natural Resources Conservation Service, 451 West Street, Amherst, MA 01002. Contact: 413-253-4350~~

[50] Contact your local NRCS office: www.nrcs.usda.gov/wps/portal/nrcs/main/national/contact/local/

~~Agriculture's Natural Resources Conservation Service, micro-irrigation systems are suited to orchard and row crops, windbreaks, greenhouse crops, residential and commercial landscape systems, on steep slopes where other methods would cause excessive erosion, or on areas where application devices interfere with cultural operations.~~

~~3. Growers should maintain adequate soil moisture for optimum plant growth without causing excessive water loss, erosion, or reduced water quality. Adding organic matter, such as manure or compost, to the soil can enhance its moisture retention capacity, reducing the need for irrigation.~~

~~3.~~4. **Where sprinkler systems are used for irrigation, the systems should be capable of uniform application of water with minimal evaporative loss and minimal surface run-off.** The amount of water applied should ~~only~~ be sufficient to fill the effective crop root zone. Irrigation during hot or windy conditions or during the peak of the day should be avoided in order to minimize evaporation.

5. **Irrigation system efficiency should be evaluated on** ~~a regular~~**an annual basis**~~. See Appendices I~~ **before each growing season.**

6. **Growers should maintain adequate soil moisture** based on crop needs for optimum plant growth without causing excessive water loss, erosion, or reduced water quality.

~~4.~~7. **Organic matter, such as manure or compost, should be added to the soil** to enhance its moisture retention capacity and ~~J.~~soil structure, thereby reducing irrigation needs and reducing runoff by allowing rainwater to soak into the ground. For every one percent of organic matter content, the soil can hold 16,500 gallons of plant-available water per acre of soil down to one foot deep[51].

[51] Scott, H.D., L.S. Wood, and W.M. Miley. 1986. *Long-term effects of tillage on the retention and transport of soil water*. Arkansas Water Resources Research Center. Publication Number 125. 39 p.24.

~~**5.0 Lawn and Landscape**~~

8. **Production soils should be kept covered throughout the year** with harvestable crops during the growing season and cover crops and/or plant residues during the off season. Cover crops can build moisture reserves better than row crops, and they open pores and channels in the soil for water infiltration; the organic matter they build helps to retain both moisture and nutrients.

8.3 Resources

- Agricultural Best Management Practices: www.mass.gov/eea/agencies/agr/about/divisions/massachusetts-ag-bmps.html
- Greenhouse Best Management Practices
- Nursery Best Management Practices
- Cranberry Best Management Practices
- Dairy Best Management Practices file size15MB
- Orchard Best Management Practices
- Small Fruit Best Management Practices
- Vegetable Best Management Practices
- Agricultural Environmental Enhancement Program: www.mass.gov/eea/agencies/agr/about/divisions/aeep.html
- NRCS Soil Resources: www.nrcs.usda.gov/wps/portal/nrcs/main/national/soils/health
- Conservation Planning: www.nrcs.usda.gov/wps/portal/nrcs/main/ma/technical/cp
- NRCS Funding Programs: www.nrcs.usda.gov/wps/portal/nrcs/main/ma/programs

9.0 Outdoor Water Use

This chapter applies to all water users.

~~The WRC formally added the Lawn and Landscape Water Conservation Standards and Guide[52] as an addendum to the Water Conservation Standards in October 2002. At that time, the Commission also adopted the following policy on outdoor water use:~~

~~*Water*~~It is the policy of the Commonwealth that water used for maintaining landscapes and lawns should not be used at the expense of public health and safety or the environment. Water ~~*that is used*~~use for maintaining landscapes and lawns should be ~~*used in a manner that minimizes such use*~~minimized through the implementation of sound water conservation and water-efficiency practices.

Sources of inefficiency in outdoor water use include applying more water than is needed to maintain healthy turf and plants and watering in the middle of the day, when evaporation rates are highest. In addition to wasting water, inefficient watering practices can lead to runoff of nutrients and pollutants, contributing to water quality problems.

Spikes in water demand may lead to water delivery problems and potential water quality, water pressure, or public safety concerns, such as diminished fire-fighting capabilities. Large peak demands may also compel managers of water systems to find new sources or increase the capacity of water systems, resulting in potential environmental impacts and higher costs for water system customers.

The ~~The above policy statement and the standards and recommendations are incorporated and defined herein along with revisions to bring them up to date.~~
standards and recommendations in this section provide guidance to all water users on practices that will reduce waste and improve efficiency in the use of water for lawns, landscapes, and other outdoor uses.

9.1 Standards

Water-Smart Principles

- ***Maintain healthy soils.***
Healthy soils retain water, cycle nutrients, minimize runoff, and absorb pollutants. For healthy turf, provide a minimum 6-inch depth.
- ***Choose native plants or plants and turf that need less water.***
Once established, native and low water-using plants require little water beyond normal rainfall.
- ***Group plants with similar water needs.***
This reduces water use by targeting water to each zone's specific needs.
- ***Be selective when adding turf areas.***
Turfgrass receives the highest percentage of irrigation in traditional landscaping. Plant turfgrass only where it has a practical function.
- ***Water wisely.***
Avoid watering during the heat of the day (9:00 AM to 5:00 PM). If using an irrigation system, make regular adjustments to ensure efficiency.
- ***Use mulch.***
Use mulch around shrubs and garden plants to help reduce evaporation, inhibit weed growth, moderate soil temperature, and prevent erosion.
- ***Provide appropriate maintenance.***
Allow turfgrass to reach 2 to 3 inches before mowing. Leave grass clippings on the lawn to return nutrients to the soil. Prune in the dormant season.

Adapted from Water-Smart Landscapes Start with WaterSense (EPA WaterSense) and Water-Wise Landscaping & Watering Guide (from WaterUseItWisely).

~~[52] For further reference, see the following publications in the References section:~~

- ~~WRC. May 2002. Guide to lawn and landscape water conservation. Avai~~ ~~http://www.mass.gov/eea/docs/eea/wrc/lawnguide.pdf.~~
- ~~EEA. 2004. More than just a yard: Ecological landscaping tools for Massachusetts homeowners. Available at http://www.mass.gov/eea/docs/eea/wrc/morethanjustyard.pdf~~

~~1. **Minimize watering lawns or landscapes**, especially in water-short communities and where the water source is in a stressed basin or sub-basin.~~

~~2. **Develop and implement seasonal demand management plans** as part of the drought management plan. These plans must identify water supply and environmental indicators (such as streamflow triggers) to serve as water use restriction triggers and outline a set of increasingly stringent and effective water-use restrictions that are designed to protect public health and the environment.~~

All Water Users

1. **Minimize lawn or landscape water needs by following established water-smart principles** (see sidebar). In most years, Massachusetts receives enough rainfall to naturally supply the water needs of a healthy, mature lawn or landscape, designed to be drought-resistant, *without the need for supplemental watering*.

2. **Maximize efficiency of irrigation.** If conditions warrant use of an irrigation system, use best management practices (see Appendix I) and the best available technology along with regular system evaluation to ensure maximum efficiency of water use.[53] If using a manual sprinkler or hand-held device, follow best management practices to maximize water efficiency (see Appendix I).

3. **During a drought or extended period of dryness,** all users should follow state guidance for limiting nonessential[54] outdoor water use during droughts (see Appendix J). Be aware that turf may become dormant (turning brown) during dry periods, but should green up again with the return of wetter conditions (see Figure 9-1).[55]

Figure 9-1. Left: Lawn in drought dormancy in July. Right: The same lawn, recovered by October. (*Photos courtesy of P. Lauenstein, Massachusetts*)

Municipal Governments and Water Districts

~~3.~~4. **Adopt and implement ~~(as appropriate)~~ a water-use restriction bylaw, ordinance, or regulation,** which applies to both municipal ~~and private wells. This~~water customers and, where warranted, those with private wells. This should limit the number of watering days per week and hours per day. To protect public health and the environment, this bylaw, ordinance or regulation should outline a set of increasingly stringent restrictions on nonessential outdoor water use, with associated triggers based on the specifics of the community's water supply. Triggers can be calendar based (such as May 1 through September 30), or identify water supply and environmental indicators (such as streamflow or reservoir levels). Drought triggers with increasingly stringent restrictions, depending on drought severity, should

[53] Massachusetts law requires system interruption devices for newly installed or renovated irrigation systems and inspection every three years by a certified irrigation contractor (MGL ch.21 sec. 67). For best available technology, see Smart Water Application Technologies (SWAT), including EPA WaterSense-labeled irrigation products (available at https://www.epa.gov/watersense/watersense-products).

[54] Essential uses are defined by MassDEP as uses required: a) for health or safety reasons; b) by regulation; c) for the production of food and fiber; d) for the maintenance of livestock; or e) to meet the core functions of a business. Nonessential uses are those *other than* essential uses.

[55] For details on managing turf to minimize water input, maximize water-use efficiency, and manage drought dormancy, see section 6 of *Best Management Practices for Lawn and Landscape Turf* (available from the UMass Extension Turf Program at https://ag.umass.edu/turf/publications-resources/best-management-practices).

also be included. **During a state-declared drought, follow state guidance on watering restrictions**.[56] The bylaw, ordinance, or regulation should provide the community government or designee (~~i.~~e.g., water supplier, police department~~, etc.)~~) with the ability to implement mandatory water-use restrictions~~. These restrictions should be tied to water supply and environmental indicators (such as streamflow triggers) as outlined in a seasonal demand management plan.~~ and empower authorities to enforce these rules through increasingly stringent citations and penalties, culminating with potential shut-offs. See Appendix B for model water-use restriction bylaws/ordinances and links to sample bylaws/ordinances.

~~4. **Abide by water restrictions** and other conservation measures implemented by the municipality or water supplier.~~

~~5. **Fully enforce water use restrictions**. This will ensure effectiveness of the restrictions so that they will be taken seriously by the public. Also, empower authorities to issue warnings to first-time offenders and citations to repeat offenders.~~

9.2 Recommendations

~~Unless otherwise noted, the following apply to: i) owners and managers of residential, industrial, commercial and institutional lawns and landscapes; ii) recreational fields and golf courses; iii) owners and managers using private wells or water sources; iv) municipal and school land managers; and v) state agencies.~~

~~In addition to these~~These recommendations~~,~~ summarize best management practices for using water efficiently outdoors. They are accompanied by the following appendices, which provide further detail and resources:

- Appendix ~~I provides a summary of~~H summarizes recommendations for lawns and landscapes~~; Appendix J includes a checklist for lawn and landscaping irrigation water efficiency; and Appendix K includes Massachusetts Turf and Landscape Irrigation Best Management Practices.~~

~~1. Establish policies, regulations, or bylaws/ordinances that ensure that land use and development practices preserve natural vegetation, preserve or restore a site's natural hydrology (by using techniques such as LID), and use low water-use/drought-resistant landscaping techniques, to the maximum extent practicable.[57]~~

~~2. Minimize Use of Potable Water and Groundwater for Lawn Irrigation. Use collected rainwater or treated wastewater to help meet outdoor water demand, whenever possible. Communities should strive to avoid application of potable drinking water for lawn irrigation purposes. Additionally, use of other groundwater sources for lawn irrigation, such as private irrigation wells, should be minimized or avoided.~~

- ~~Control~~ Appendix I outlines best management practices for watering and for irrigation system efficiency

All Water Users

1. **Plan landscapes** with the understanding that many communities limit nonessential outdoor water use to one or two days a week, with water bans possible during drought conditions.
2. **Cover swimming pools when not in use** to prevent evaporative losses.[58]

[56] See Appendix J for statewide guidance on watering restrictions at different levels of drought.

~~[57] For more information see: "Create a Framework: By-laws and other Regulations" in "Summer Smart Water Use, A Guide to Peak Season Water Demand Management for Massachusetts Communities" (MAPC and Arc of Innovation, 2006), and Refer to the EEA LID webpage (and the Massachusetts Smart Growth/Smart Energy Toolkit (http://www.mass.gov/envir/smart_growth_toolkit/) for details on LID.~~

3. **Sweep driveways, walks, patios, and other outdoor areas with a broom rather than hosing them off**. If water is necessary, use a water-conserving pressurized cleaning device.[59]

4. **Wash vehicles using a bucket and sponge, employing a hose with a shut-off nozzle for rinse only, or, if available, use a commercial car wash that recycles water (most do)**.

5. **Do not divert water directly from any water sources**, including ponds, lakes, streams or rivers, or groundwater, without first obtaining approval from the local Conservation Commission or the Massachusetts Department of Environmental Protection.[60]

Municipal Governments and Water Suppliers

6. **Adopt bylaws/ordinances, policies, or regulations** that include some or all of the following provisions:

To address water-use efficiency of irrigation systems:[61]

3. require registration, inspection, and~~Outdoor Water Use – Limit the number of watering days per week or per month (in most years Massachusetts generally has enough rainfall to naturally supply the water needs of a healthy mature lawn, designed to be drought resistant, *without the need for watering*). Clients and other users of lawns, recreational fields, etc. should be informed that some turf grasses naturally go brown and dormant during hot dry weather and will usually revive when cooler, wetter weather returns. See Appendices H, I, and J for more information on watering.~~

4. ~~Infiltrate Rainwater – Redirect gutter downspouts or rainwater collection overflow spouts away from pavement and into places where water can infiltrate into the ground, like a rain garden.~~

5. ~~Irrigate Efficiently – Water only when necessary. The amount of water applied should be sufficient to only fill the effective root zone and minimize evaporative loss. Do not water during precipitation events, and avoid watering in windy conditions, and during the hottest part of the day (8am to 6pm).~~

6. ~~Maximize Water Conservation of **Automatic Irrigation Systems** – Use the best available technology to ensure maximum water efficiency and conduct regular irrigation~~ audits ~~to evaluate and adjust water efficiency.~~

   - ~~Install water conservation equipment including moisture sensors, rain shut-off devices, and climate-based controllers. Basic recommended features of a good irrigation system controller are outlined in Appendix I and associated references.~~
   - ~~Properly operate and maintain~~ of automatic irrigation systems~~. Sprinkler irrigation systems should be capable of uniform application of water with minimal runoff and evaporative loss. Evaluate irrigation system efficiency on a regular basis. A do-it-yourself checklist for evaluating lawn and landscape irrigation efficiency is included in Appendix J. Appendix K provides additional Best Management Practices for lawn and landscape irrigation. ~~;
   - ~~Avoid installing automatic lawn irrigation systems in water-short communities. Where local bylaws do not restrict or prohibit the installation and operation of irrigation systems, they should nevertheless prohibit the operation of those systems that are wasteful (e.g. municipalities should~~

[58] See "Water Efficiency Measures for Swimming Pools" in section 4.6.1 of *Handbook of Water Use and Conservation* (Amy Vickers. 2001. Amherst, MA: WaterPlow Press).

[59] A water-conserving pressurized cleaning device is one that either (a) discharges water at a minimum of 1,000 pounds per square inch (psi), or (b) is rated at using less than three gallons of water per minute.

[60] Water used for agricultural operations (as defined in MGL Chapter 128 section 1A) is considered an essential use. However, a Water Management Act permit may still be required if withdrawals exceed certain thresholds. Agricultural operations should confirm permitting requirements with MassDEP.

[61] See Appendix B, DEP Model Outdoor Water-Use Restriction Bylaw/Ordinance.

issue fines forprohibit the operation of, and authorize fines for, irrigation systems that spray and/or run off significant amounts of water onto unplanted surfaces such as sidewalks, and driveways, etc.; or systems that wateroperate during or after rainfall events).;

7. Enhance Soil Health – Ensure adequate depth and type of soil. At least 6 inches of topsoil is recommended. Generally, a sandy loam with 5% organic content is recommended for turf grass and landscapes. Some tips for soil improvement include using peat moss, manure or compost to improve moisture retention, and using organic fertilizer for strong root growth.[62] Avoid pesticides that also kill beneficial organisms such as earthworms that aerate and fertilize the soil naturally. Choose proven biological pest management materials to control grubs. See Appendix I for more information.

8. Mow High, Often, and Sharp – Mow lawns at the highest recommended height (at least 2.5 inches), and do not allow grass to grow higher than about 4 to 5 inches. Sharpen the mower blades to cut the grass blades cleanly rather than shred them; this will minimize water loss and help to reduce the chances of disease infestation. Allow grass clippings to decompose where they fall, and contribute to the organic content of the topsoil. If clippings tend to be very clumpy, simply mow over them again to cut them into smaller pieces. This will help them to filter down into the lawn, decompose more quickly, and prevent smothering of grass plants.

9. Plant According to Micro-Climates – Be aware of the various micro-climates in your yard (hot/sunny, cool/shady, moist, dry, etc.) and plan your gardens and plantings accordingly. Do not plant water-loving plants unless you have the natural conditions to support them without supplemental irrigation. There are many varieties of low water use plants that can minimize the need for supplemental watering and provide additional wildlife value.[63]

Additional Recommendations

Owners and Managers of Recreational Fields and Golf Courses

- Design and maintain facilities to minimize water use, ideally relying on rainwater to meet all irrigation needs.
- If studies indicate that irrigation is required to maintain proper turf health and safe athletic fields, follow best management practices outlined above and in Appendix I and associated references, to minimize water use.

Owners and Managers using Private Wells or Water Sources

- Abide by local water restrictions.
- Unless properly permitted, do not withdraw water directly from any ponds, lakes, streams or rivers, except for any ponds constructed specifically for irrigation purposes.

Municipalities and other Public Water Suppliers

- Establish policies, regulations, or bylaws/ordinances that ensure that land use and development practices preserve natural vegetation, preserve or restore a site's natural hydrology, and use low water-use/drought-resistant landscaping techniques, to the maximum extent practicable.[64]

[62] The following websites provide additional information on proper care and maintenance of turf and landscape plants, and describe the importance of amending soils with organic matter for improving the soil's water retention characteristics for reducing water consumption.
   a. www.umassgreeninfo.org b. www.umassturf.org
   c. American Horticultural Society http://www.ahs.org/publications/the-american-gardener/0005/smartgarden.htm
   d. Greenscapes Massachusetts (http://www.greenscapes.org/)

[63] For a list of Northeastern US Native Plants that are drought tolerant and/or have wildlife benefits see Appendix 1 in "More Than Just A Yard, Ecological Landscaping Tools for Massachusetts Homeowners" (EEA, 2004)

[64] For more information see: "Create a Framework: By-laws and other Regulations" in "Summer Smart Water Use, A Guide to Peak Season Water Demand Management for Massachusetts Communities" (MAPC and Arc of Innovation, 2006)

- ~~Consider developing a water conservation bylaw that includes some or all of the following provisions:~~
  - ~~requires~~require water conservation equipment ~~and audits for~~ , including system interruption devices, on automatic irrigation systems;[65]
  - ~~requires registration of~~ where water resources are limited, prohibit the installation of automatic irrigation systems~~;~~.

~~minimizes~~***~~To minimize water use through land use planning~~*** [66]

- minimize installation of high water-use landscape areas~~;~~[67]
- ~~restricts~~limit land clearing and ~~lawn size in new developments and requires~~loss of vegetated cover and preserve natural vegetation;
- prohibit topsoil stripping and earth removal and require a minimum 6-inch depth of topsoil[68] on all cleared areas to help retain moisture; ~~and,~~
- ~~prohibits topsoil stripping.~~

- ~~Raise public awareness through an education and outreach program on outdoor water use, featuring alternatives to traditional lawn watering, demonstrations of water-wise landscaping and efficient irrigation practices on municipal properties (which also include school departments and recreation and athletic fields).~~
  - ~~Provide landscape water audits~~restrict topographic alterations and require that natural topography be maintained to the maximum extent feasible;
  - preserve or restore a site's natural hydrology (by using techniques such as low-impact development and open-space design);
  - require the use of low water-use/drought-resistant plants, turf, and landscaping techniques; and
- encourage or require the use of native, noninvasive plants,[69] appropriate for ~~residential, industrial, commercial,~~the site and ~~public properties that are large water users.~~
  - ~~Provide rebates~~selected for their ability to adapt to the ~~installation of~~local climate ~~based controllers and/or moisture sensors for automatic irrigation systems.~~;

~~Control direct~~***~~To address protection of surface~~*** ***water*** ***~~sources:~~***

- control withdrawal ~~from water bodies. Communities should consider adopting an ordinance that prohibits the taking~~ of water from any surface water source ~~without~~by requiring advance written ~~permission~~approval from the Conservation Commission ~~and paying the same (or more) for the water as it would have cost the proponent to obtain it directly from the public water supplier. Passing such a bylaw~~ . Such a bylaw/ordinance would help control the ~~documented~~ problem of ~~hydro-seeding or other water tanker trucks withdrawing~~unauthorized withdrawals directly from local waterways, taking water without permission or paying for it, and sometimes contaminating the body of water from which the water was withdrawn.

~~Note: The water used for agricultural operations (as defined in M.G.L. c.128 section 1A) is necessary for these commercial activities to continue. Therefore, the conditions of this section should not cover water used by agricultural operations.~~

~~State Agencies and Property Managers~~

[65] System interruption devices are required by Massachusetts law (MGL chap. 21 sec. 67) for new or renovated systems.

[66] See links to bylaws/ordinances and regulations containing these provisions in Appendix B.

[67] EPA's WaterSense Water Budget Tool can be used to guide landscape design and calculate an efficient allotment of water for a landscape in a specific climate. See resources at the Tool's webpage: http://www.epa.gov/watersense/water_budget/.

[68] Generally, a sandy loam with 5% organic content is recommended for turf grass and landscapes. See more tips in Appendix H.

[69] A list of native plants can be found in Appendix 1 of EEA's *More than just a yard: Ecological landscaping tools for Massachusetts homeowners* (2004). Available at http://www.mass.gov/eea/docs/eea/wrc/morethanjustyard.pdf.

7. ~~State agencies and property managers should use their property to demonstrate the development and management of low-water-use landscapes. Appropriate public~~ **Maintain an inventory of automatic irrigation systems**. This can help prevent and better respond to backflow problems or performance issues resulting from improperly installed systems, and supports identifying customers who may benefit from an irrigation audit or education on how to more efficiently use their system.

8. **Provide outdoor water-use audits** for residential, industrial, commercial, and public properties that are large water users.[70]

Raise public awareness through an education and outreach ~~should publicize these efforts. In addition, state property managers should practice the following:~~

- ~~Implement water-wise~~**program on outdoor water use**, featuring demonstrations of water-smart landscaping and ~~use of native vegetation to reduce outdoor watering. Emphasize the advantages of~~ efficient irrigation practices ~~(e.g. drip irrigation) over broadcast watering. Promote these measures in educational campaigns.~~

~~10.~~9. ~~Where feasible, use non-potable water supplies (like rainwater harvesting, stormwater infiltration, and treated wastewater) for landscaping, street cleaning and building washing, recognizing public health considerations and plumbing board decisions. State and~~ on municipal ~~facilities often include large areas of impervious surfaces (building rooftops, parking lots, etc.), which offer excellent opportunities for rainwater harvesting that can serve as a supplemental water supply source and can provide opportunities to infiltrate clean runoff into the ground where it can replenish aquifers and streamflow.~~properties (including school departments and recreation and athletic fields). Inform customers through water bills or other means of their obligation to comply with the provisions of bylaws/ordinances outlined in Recommendation 6.

~~**State Regulatory Programs**~~

- ~~The MassDEP is responsible for issuing permits under the WMA for those withdrawing more than 100,000 gpd from new water supply sources, or those increasing withdrawal from existing sources. The MassDEP should continue to condition the permits of water supply sources to avoid significant environmental impacts. MassDEP should also work to assist water suppliers in developing seasonal drought/demand management plans and in providing technical assistance to those adopting and implementing water-use restrictions as appropriate.~~
- ~~The Commonwealth, in conjunction with potentially regulated communities and other interested parties, should evaluate the benefits of establishing a licensing or certification program for irrigation professionals incorporating an ecological component. This program should cover potential environmental impacts to aquatic ecosystems that can result (directly or indirectly) from irrigation conducted in an environmentally responsible manner.~~

~~**State Procurement Activities**~~

10. ~~State agencies responsible for the renovation and maintenance of state facilities, and state agencies that procure~~**Calculate a summer-to-winter water-use ratio** as a benchmark for evaluating the community's outdoor water use. Use the following formula:

    Total water use in May through September (summer)/total water use in November through March (winter)

    Track trends; if the ratio trends upwards, determine the cause and take appropriate action to reduce summer water use.

[70] See Appendix I for guidelines on irrigation audits and best management practices for irrigation system efficiency.

Managers of Recreational Fields, Parks, Golf Courses, and Institutional and Commercial Landscapes

11. **Consider using the WaterSense Water Budget Approach**[71] to designing landscaped areas that will use water efficiently.

12. **If irrigation is necessary to maintain turf health and functionality, follow best management practices outlined in Appendix I to minimize water use**.

13. For those in areas where water resources are limited or who desire to eliminate potable water use outdoors, first **design the landscape to take advantage of natural rainfall to satisfy watering needs**. If watering needs cannot be met by rainfall, consider other sources (such as rainwater harvesting or treated wastewater), where feasible.[72]

Rainwater harvesting using a rain barrel

~~11.~~14. **In procuring services for lawn and landscape maintenance** ~~should~~, ensure that the appropriate lawn and landscape design, irrigation design, and maintenance and construction guidelines for minimizing outdoor water use are included in the procurement bid documents and ~~in the~~ bid evaluation criteria.[73]

Public Property Managers

15. **Use public properties to demonstrate the development and management of water-smart landscapes** and the use of native and drought-tolerant vegetation to reduce outdoor watering. Public education and outreach programs and signage should accompany these efforts.

16. If irrigation is used on public properties, **demonstrate the advantages of efficient irrigation practices** (e.g., drip irrigation).

9.3 Resources

- EEA (Executive Office of Energy & Environmental Affairs). Tips for Saving Water. Available at http://www.mass.gov/eea/docs/eea/eea-tips-for-saving-water.pdf
- EPA WaterSense. August 2012. *Water-Smart Landscapes: Water-Efficient Landscapes Start with WaterSense*. Available at http://www.epa.gov/watersense/docs/water-efficient_landscaping_508.pdf
- EPA WaterSense. July 24, 2014. WaterSense Water Budget Approach. Version 1.02. Available at https://www.epa.gov/watersense/water-budget-tool

[71] See link to the Water Budget Tool in note 67.

[72] See the Alternative Water Sources tab on the Commercial Buildings, Best Management Practices page at https://www.epa.gov/watersense/best-management-practices).

[73] Links to EPA's WaterSense specifications, the Water Budget Tool, and other resources on landscape design and irrigation system design can be found on the WaterSense Homes page at https://www.epa.gov/watersense/homes, and on the Outdoors page at https://www.epa.gov/watersense/outdoors.

9.4 Related Appendices

- Appendix B, Model Bylaws
- Appendix H, Summary of Water Conservation and Water Quality Recommendations for Lawns and Landscapes
- Appendix I, Guidelines for Efficient Irrigation

Case Study

Scituate reduces per capita use by targeting water conservation program to largest users

In 2011, the town of Scituate found that high demand for water in the summer was placing a strain on its water sources, wells and water treatment plant and sometimes reduced its capacity to respond to emergencies. The Scituate Water Division wanted to figure out what was driving this high demand. With assistance from the North & South Rivers Watershed Association (NSRWA) and Massachusetts Bays Program, the Water Department first analyzed data that was readily available: its own customer accounts.

Solution

Using a simple Excel spreadsheet, the Water Department found that the top ***5% of its residential customers were responsible for 20% of total water use and these customers increased their use by 25% in the summer***. The water commissioners felt this usage was being driven by automatic lawn irrigation systems and adopted a restriction that limited the use of lawn irrigation systems connected to the municipal water supply to one day per week. Each voting precinct is assigned a lawn irrigation day. The restriction also requires property owners with private wells supplying their irrigation systems to register their wells with the Water Department.

Results

Scituate ***reduced water use on average by 310,000 gallons per day*** in the summer months, and has **lowered its residential per capita use from 77 gpcd** (in 2007) **to an average of 63 gpcd** (2013 to 2014). The summertime conservation savings has allowed Scituate to begin to restore streamflow and herring populations to the First Herring Brook and its reservoir system by following an operational plan that includes seasonally adjusted streamflow releases.

Scituate: http://www.scituatema.gov/sites/scituatema/files/file/file/water-restrictions-notice-2012.pdf
NSRWA: http://www.nsrwa.org/environment/restoring-fish-streams/first-herring-brook/

10.0 Public Education and Outreach

This chapter applies primarily to:

- *Water suppliers*
- ~~*Water distributors*~~

- *Municipal ~~governing~~ bodies, boards, and departments*
- *Municipal facilities and public works personnel*
- *State policy and regulatory entities*

The responsibility for ensuring a sustainable water future lies with the community as a whole; everyone has a role to play to make sure that all water (rainwater, stormwater, public water supply, etc.) is handled responsibly and planned for properly.

Education of the public at large, municipal officials, and ~~the~~ water suppliers is crucial to generating an understanding of the issues and implementing and creating acceptance of water conservation activities. It is important to provide to the public the basic understanding of sound water resources management and planning and explain the associated economic and environmental benefits.

Public education and outreach can facilitate the successful adoption and implementation of conservation measures. For example, public acceptance of and compliance with outdoor watering restrictions can be enhanced if they are preceded by an outreach effort that clearly establishes the need for such restrictions in terms of maintaining system reliability, avoiding or postponing expensive system expansion, safeguarding ~~hydric~~aquatic habitats, etc.

~~Four main~~Potential areas of emphasis for an educational program ~~should be~~include:

- Highlighting the environmental benefits of ~~keeping water local and~~ reducing water demands~~. This should include~~ and preserving the hydrologic balance (the natural volumes of water moving through stream systems and the surrounding landscape) – a.k.a. "keeping water local." Key education ~~regarding~~points might include the connection between ground water and surface water; the potential impacts of withdrawals on streamflow and instream uses such as habitats for fisheries and other wildlife, water-based recreation, pollution dilution; and the relationship between pumping and salt water intrusion for coastal areas.
- Explaining that water conservation helps preserve water quality ~~as well.~~. Both ground and surface water sources can face deteriorating water quality if pumped excessively. Conservation also helps septic systems ~~work better and last longer,~~ and ~~helps~~ wastewater treatment plants ~~function~~work better and last longer. Water conservation also ~~enables~~keeps more water ~~to be retained~~ in the natural environment where it helps dilute pathogens and other ~~pollutant concentrations,~~pollutants and buffers waterways from excessive heating or freezing that can harm aquatic life.
- Showing that investments in efficiency and conservation will provide water users with long-term savings compared to the cost of developing and treating new water supply sources and expanding wastewater treatment facilities. ~~For example, through a domestic device retrofit program, including publicity, follow-up visits or mailings, water suppliers can make customers aware that making a few simple changes can provide tangible savings~~Domestic fixture retrofit programs can provide a good opportunity for this message.
- ~~Explaining to~~Educating water users on all the costs involved in providing water, including planning, engineering, construction, source protection, operation, maintenance, treatment, wastewater facilities costs, ~~piping~~distribution, metering, leak detection, compliance costs, ~~salaries, protection~~personnel costs, ~~pensions, health care, staff training,~~ and public ~~education~~outreach.
- Making the connection between water use and energy costs. For water utilities, the energy required to pump, treat, and distribute water and collect wastewater is significant~~, representing about twenty-five~~

~~percent of total operation and maintenance costs~~.[74] Implementing improvements in both energy and water efficiency can reduce operating costs, providing an opportunity to redirect funds to other needed water system improvements. Reducing water use at the household level can also reduce energy use and the costs associated with heating water and operating water-using appliances.

10.1 Standards

1. Each community and water supplier ~~or distributor:~~ should **develop and implement an education plan**, ~~which includes most, if not all, items~~including elements in the following list, as applicable:
   - ~~Target the largest users early on to realize the greatest potential savings and to demonstrate the benefits of a conservation program.~~
   - ~~Include in bill stuffers or bills a work sheet on the reverse to enable customers to track water use and conservation efforts and estimate the dollar savings. Also, provide a table enabling the recipient to estimate the household gpcd to see how it compares with the 65 rgpcd standard (see Appendix C).~~
   - **Billing**: Help customers track, compare, and make meaning of their use through their water bills (see Chapters 3 and 4 for specific billing suggestions). Specialized billing software is available to help track individual customer use and even target outreach to customers who may have a leak or who are using significantly more water than similar customers.
   - **Indoor Retrofit/Rebate Programs:** Offering indoor low-flow retrofit devices or rebates for water-efficient appliances provides opportunities to educate customers on the financial and environmental benefits of water conservation.
   - **Lawn and Landscaping Programs:** Information on "water-wise landscaping", gardening, efficient irrigation, and lawn care practices can be provided through model landscapes, workshops, online information, and partnerships with local garden clubs, lawn and landscape retailers, and environmental organizations.
   - **Local Schools:** Partnering with teachers and school administrators to develop age-appropriate curricula on the local water system and the importance of water conservation can help bring these messages back home and integrate them into the community.
   - ~~**Diverse Outreach Tools:** Use public space advertising/media to highlight stories on successes (and failures).~~
   - ~~Take advantage of~~ social ~~networking~~media, online tools, public service announcements, local events, etc. to communicate water conservation messages and alerts, incorporating multilingual materials as needed.
   - ~~Establish conservation information centers perhaps run jointly with electric or gas company.~~
   - ~~Encourage speakers for community organizations.~~
   - **Partnerships:** Partner with garden clubs, farmers' markets, environmental organizations, energy utilities, and others on campaigns promoting wise water use.
   - ~~Sponsor public service announcements and radio/T.V./audio-visual presentations on supply sources and current status.~~
   - ~~Conduct joint advertising with hardware stores to promote conservation devices.~~
   - ~~Use civic and professional organization resources.~~
   - ~~Sponsor special events such as Conservation Fairs.~~
   - ~~Make available multilingual materials as needed.~~

[74] See EPA, 2008: Ensuring a Sustainable Future: An Energy Management Guidebook for Wastewater and Water Utilities. Available at ~~http://www.epa.gov/owm/waterinfrastructure/pdfs/guidebook_si_energymanagement.pdf~~ https://nepis.epa.gov/Exe/ZyPDF.cgi/P1003Y1G.PDF?Dockey=P1003Y1G.PDF

- ~~Incorporate contests and recognition for innovation into the public education program.~~
- ~~Organize water conservation workshops for the general public and include them~~For communities in ~~the school curriculum.~~
- ~~Provide information on water-wise landscaping, gardening, efficient irrigation, and lawn care practices.~~
- ~~Include education information in retrofit and rebate programs.~~

~~Water users and agencies should choose from these and other resources to create and implement programs best suited for their particular situation. The education plan should especially target school children with age-appropriate media that appeals to children, including getting them involved in water resource projects and field trips.~~

2. ~~As part of a public education program, **address the issue of why it is equally important for self-supplied water users** (e.g.,~~which some homes or businesses rely on ~~their own~~ private wells~~) **to conserve water**, especially when their water source might dry up an~~**, help those users understand, where appropriate, the impacts of their withdrawals on the public water supply system and local aquatic habitat** ~~or deplete the water available for public use (e.g., their withdrawal point taps the same aquifer as a nearby public wellfield).~~**and the importance of their own efforts at water conservation.**

10.2 Recommendations

1. ~~~~Communities/water suppliers should **hire** ~~a part~~ **or** ~~full time~~**contract with a water conservation coordinator or circuit rider** shared among several water systems~~. A draft job description for~~ or partner with a local advocacy or educational organization to help advance water conservation ~~coordinator is included in Appendix G.~~

2.~~1.~~ ~~To facilitate implementation of these standards a position of State Water Conservation Coordinator should be established in the Executive Office of Energy and Environmental Affairs to work with water suppliers, industries, watershed associations, and other local entities as well as with existing state programs~~goals.

3.~~2.~~ Water suppliers and the state should **consider using social marketing to help build public support for water conservation**. Social marketing is a valuable technique that focuses on the most effective ways to change behavior, leading people to adopt and implement sustainable practices.~~.~~[75]

4.~~3.~~ **Other town boards should get involved in water conservation**, especially those regulating land use (Planning and Zoning Boards), managing Town property (park and recreation departments, cemetery departments, and schools), ~~looking after~~protecting water resources and aquatic habitats (Conservation Commissions, Boards of Health), ~~and~~ Open Space~~/~~ Committees, and Community Preservation ~~committees~~Committees. These entities can help promote water conservation as well as restore the hydrological balance by enhancing infiltration of clean water into the ground, thus replenishing aquifers and streamflow.

~~**REFERENCES**~~

~~AWWA (American Water Works Association). 2002. *Drought management handbook*. Denver, CO: American Water Works Association.~~

~~AWWA (American Water Works Association). 2006. Water conservation programs—A planning manual (M52). Denver, CO: American Water Works Association.~~

[75] Fostering Sustainable Behavior through Community-Based Social Marketing http://www.cbsm.com. "Community-based social marketing draws heavily on research in social psychology, which indicates that initiatives to promote behavior change are often most effective when they are carried out at the community level and involve direct contact with people."

EEA (Executive Office of Energy and Environmental Affairs). 2004. *More than just a yard: Ecological landscaping tools for Massachusetts homeowners*. Available at http://www.mass.gov/eea/docs/eea/wrc/morethanjustyard.pdf

EEA (Executive Office of Energy and Environmental Affairs). 2004. Massachusetts Water Policy. Available at http://www.mass.gov/eea/air-water-climate-change/preserving-water-resources/massachusetts-water-policy-2004.html.

EEA (Executive Office of Energy and Environmental Affairs). 2007. 2nd ed. Smart Growth/Smart Energy Toolkit. Available at http://www.mass.gov/envir/smart_growth_toolkit/.

EPA (Environmental Protection Agency). July 2002. Cases in water conservation: How efficiency programs help water utilities save water and avoid costs. EPA832-B-02-003. Available at http://www.epa.gov/WaterSense/docs/utilityconservation_508.pdf.

EPA (Environmental Protection Agency), Office of Wastewater Management. 2003. *Water and wastewater pricing, An informational overview*. EPA 832-F-03-027. Washington, DC: U.S. EPA, Office of Wastewater Management. Available at http://www.epa.gov/owm/waterinfrastructure/pricing/pdfs/waterpricing_final2.pdf.

Frederick, Kenneth D., 1998. Marketing water. The obstacles and the impetus. *Resources*, Issue 132, Summer, pp. 7-10. Available at http://www.rff.org/rff/Documents/RFF-Resources-132-water.pdf.

Gaudin, S. 2006. Effect of price information on residential water demand. *Applied Economics* Vol. 38, 383-93. Available at http://ron-griffin.tamu.edu/AgEc677reads/gaudin2006.pdf.

Infiltration/Inflow Task Force. March 2001. *Infiltration/inflow task force report: A guidance document for MWRA member sewer communities and regional stakeholders*. Available at http://www.mwra.state.ma.us/comsupport/publications/iitaskforcereport-march2001.pdf

Maddaus, W.O. 1987. *Water Conservation*. American Water Works Association. Denver, CO.

MAPC (Metropolitan Area Planning Council) and Arc of Innovation. May 2006. Summer Smart Water Use: A Guide to Peak Season Water Demand Management. Boston, MA. Available at http://www.mapc.org/resources/watersmart-toolkit.

Massachusetts Department of Agricultural Resources. July 1997. 1st ed. *A homeowner's guide to environmentally sound lawncare: Maintaining a healthy lawn the IPM way*. Available at http://www.mass.gov/agr/pesticides/publications/docs/IPM_Lawn_Guide_1A.1.pdf

MassDEP (Massachusetts Department of Environmental Protection). Feb. 1997. Declaration of a state of water supply emergency. Drinking water policy No. 87-05, revised 2/97. Available at http://www.mass.gov/dep/water/laws/8705.pdf.

MassDEP (Massachusetts Department of Environmental Protection). 2007. *Water resource management planning* guidance document. Available at http://www.mass.gov/dep/water/laws/policies.htm#wrmp.

MassDEP (Massachusetts Department of Environmental Protection). February 2008. Massachusetts stormwater handbook. Two volumes. Available at http://www.mass.gov/dep/water/laws/policies.htm.

MassDEP (Massachusetts Department of Environmental Protection) and DeFeo, Wait & Associates, Inc. 1991. *Technical evaluation* — Title 5 the state environmental code, 310 CMR 15.00. Boston, MA: Commonwealth of Massachusetts.

Maximum Performance (MaP) of WaterSense® High-Efficiency Fixtures . March 5, 2012, or latest edition (updated periodically). Available at http://www.map-testing.com/about/maximum-performance.html and http://www.map-testing.com/assets/files/2012-03-05-tank-type-toilets.pdf.

MWRA (Massachusetts Water Resources Authority). Garden and landscaping water conservation tips. Available at http://www.mwra.state.ma.us/04water/html/gardening.htm

Mayer, P.W., W.B. DeOreo, E.M. Opitz, J. C. Kiefer, W.Y. Davis, B. Dziegielewski, and J.O. Nelson. 1999. *Residential end uses of water*. Denver, CO: AWWA Research Foundation and American Water Works Association. Available at www.aquacraft.com/. Full report available at http://www.waterrf.org/ProjectsReports/PublicReportLibrary/RFR90781_1999_241A.pdf

Mayer, P.W., W.B. DeOreo, and D.M. Lewis. 2000. *Seattle home water conservation study: The impacts of high efficiency plumbing fixture retrofits in single-family homes*. Submitted to Seattle Public Utilities and U.S. Environmental Protection Agency by Aquacraft, Inc. Water Engineering and Management, Boulder, CO. Available at http://www.cuwcc.org/docDetail.aspx?id=2540.

McIntosh, R. 2005. Irrigation water audit and landscaping water efficiency. *Journal of The New England Water Works Association* Volume 119 No. 2, June.

National Research Council, 1995. *Mexico City's water supply. Improving the outlook for sustainability*. Washington DC: National Academy Press.

NEWWA (New England Water Works Association). 2009. Best management practice – Conservation pricing: rate setting, metering, and billing considerations to encourage water conservation. May 29, 2009. Available at http://www.newwa.org/Media/waterUtilityNews.htm.

Rosegrant, Mark W. 1997. Water resources in the twenty-first century: Challenges and implications for action. Food, Agriculture, and the Environment Discussion Paper 20. Washington, DC: International Food Policy Research Institute. Available at http://ageconsearch.umn.edu/bitstream/42317/2/dp20.pdf.

Tighe & Bond. 2010. *2010 Massachusetts water rate survey*. Westfield, MA. Available at http://rates.tighebond.com.

- Vickers, Amy. 2001. *Handbook of water use and conservation*. Amherst, MA: WaterPlow Press.

Wagner, Judith W., and Russell A. Cohen. 1990. *Conservation works: The ecological benefits of conserving water*. Massachusetts Riverways Program. Available at http://www.mass.gov/dfwele/der/riverways/resources/guides.htm.

Wang, Young-Doo; William James Smith, Jr.; and John Byrne. 2005. Water conservation-oriented rates: Strategies to extend supply, promote equity, and meet minimum flow levels. Denver, CO: American Water Works Association.

WRC (Massachusetts Water Resources Commission). 1996. *Massachusetts water supply policy statement, 1996 update*. Boston, MA. Available at http://www.mass.gov/eea/docs/eea/wrc/watersupply-policy.pdf.

WRC (Massachusetts Water Resources Commission). September 13, 2001. Interbasin Transfer Act performance standards guidance. Appendix B, Local Water Resources Management Plan Outline. Available at http://www.mass.gov/dcr/watersupply/intbasin/download.htm.

WRC (Massachusetts Water Resources Commission). December 2001. *Stressed basins in Massachusetts*. Available at http://www.mass.gov/eea/air-water-climate-change/preserving-water-resources/partners-and-agencies/water-resources-commission/stressed-basins-in-massachusetts-report.html.

WRC (Massachusetts Water Resources Commission). May 2002. *Guide to lawn and landscape water conservation*. Available at http://www.mass.gov/eea/docs/eea/wrc/lawnguide.pdf.

WRC (Massachusetts Water Resources Commission). October 2002. Lawn and landscape water conservation – An addendum to the water conservation standards for the commonwealth of Massachusetts.

WRC (Massachusetts Water Resources Commission). 2008. Water conservation questionnaire for public water suppliers. Available at http://www.mass.gov/dcr/watersupply/intbasin/download.htm.

~~RESOURCES~~

~~Alliance for Water Efficiency. http://www.allianceforwaterefficiency.org/.~~

~~Greenscapes Massachusetts. *Greenscapes guide*. Available at http://www.greenscapes.org/.~~

~~Home Water Works web site. A project of the Alliance for Water Efficiency. Available at http://www.home-water-works.org/.~~

~~MaP – Maximum Performance Testing: A cooperative Canadian-American project to provide testing of toilets for efficiency and performance. Search capabilities and results available at http://www.map-testing.com/.~~

~~MassDEP (Massachusetts Department of Environmental Protection). Wastewater Reuse web page. Available at http://www.mass.gov/dep/water/wastewater/reuse.htm.~~

~~Water Sense, a partnership program of the U.S. Environmental Protection Agency to identify and label water-efficient products, new homes, and services. WaterSense-labeled products and services available at http://www.epa.gov/watersense/.~~

APPENDICES

A) Water Bank Guidance

~~A) Water Bank Guidance~~

B) Model Bylaws

C) ~~Education and Outreach Materials~~

~~D) Plumbing Fixtures and Appliances:~~Example Water~~ Use Data and~~ Bill Insert

D) Improvements in Household Water~~ Use~~ Efficiency and Standards

E) Residential Water-Use Data and Benchmarks

F) BMPs for Selected Industries

~~G) Water Conservation Coordinator Job Description~~

~~H~~G) Sample Worksheet for Industrial / Commercial / Institutional Water Audit

~~I~~H) Summary of Water Conservation and Water Quality Recommendations for Lawns and Landscapes

~~J) Checklist~~I) Guidelines for ~~lawn and landscaping irrigation water efficiency~~

~~K) Turf and Landscape~~Efficient Irrigation~~ Best~~

J) Massachusetts Drought Management ~~Practices~~

~~L) Local~~Outdoor Water ~~Conservation Efforts~~Use Restrictions Guidelines

A) Water Bank Guidance

~~**A) Water Bank Guidance**~~

~~Demand management facilitates the generation of physical savings of water as well as economic savings (Rosegrant 1997) – i.e. it brings about conservation in order to help sustain current and future supplies and induces an effective cost recovery system (National Research Council 1995). Economic instruments that can be used could be tradable water permits, water pricing, or water banking. These instruments are based on the premise that a value can be associated with each water-use activity and it is this differential that makes transfers or purchases possible and attractive.~~

Demand reduction is an effective way to increase efficiency and sustainability of water systems. A water bank can help finance actions that directly reduce demand.

What is a 'Water Bank'?

Over the years, a "water bank" has come to mean different things to different people. In the western states, water banks are typically systems of valuing, trading, buying or selling water rights. Permanent water banks have been established in Idaho and Texas. The state of California, in 1991, 1992 and 1994, set up emergency drought water banks to reallocate water. Water was purchased from those farmers who were willing to leave their lands idle or were willing to use groundwater instead of surface water. This was then sold to either cities or farms or used for instream uses or to dilute pollutants (Frederick 1998).

In Massachusetts, the term water bank is evolving to mean a system of accounting and paying for measures that offset or mitigate water losses. Losses could be due to water withdrawals, sewering, and/or increased impervious areas that prevent aquifer recharge. The primary goals of a water bank are to balance the water budget, reduce water losses, increase water efficiency, and keep water local.[76] There is no "one size fits all" approach, and municipalities should have the flexibility to adopt a program that best fits their particular circumstances.

The Benefits of a Water Bank

Water banking can be an effective management tool for "water-short" communities where development pressure is exceeding the carrying capacity of water resources. It is also a good option for communities concerned about their ability to meet projected water demand and to protect the environment. A water-banking program can free up water and ensure that there is an adequate supply of water for competing uses – i.e., instream flow and habitat, recreation, wetlands, water supply, and economic development. It can mitigate, or offset, the impacts of water withdrawals, balance the water budget, assist in restoring and protecting instream flow, promote water conservation, and ensure an adequate supply of potable water. Massachusetts' communities are beginning to use this tool to accommodate future growth while ensuring the sustainability of their water resources.

Key Principles

There are some key organizing principles that communities should follow when developing an effective water-banking program. They are:

1. A dedicated fund, or banking mechanism is necessary
2. At least a 2:1 ratio ~~for mitigation~~of water saved or returned to the basin per unit of water lost should be the goal in ~~medium- and high-stressed~~flow-depleted basins

[76] Interbasin transfers, for example, are not subject to inclusion in a water bank as they by definition do not keep water local. However, reductions in the amount of water transferred out-of-basin, via sewers for example, would qualify as mitigation. See the Water Resources Commission's ~~Offsets Policy Regarding Proposed Interbasin Transfers (October 11, 2007).~~Offsets Policy Regarding Proposed Interbasin Transfers (October 11, 2007).

3. If fee-based, the fee charge must bear a reasonable relation to the cost of implementing the offset and the program's administrative costs, and
4. If the work is performed by the developer, documentation must be provided~~,~~ and there must be verification by the local department or board administering the program.

Because a 1:1 ratio only preserves the status quo in already degraded watersheds, and because measuring the gains from individual water offset measures is often imprecise, to protect or restore water resources especially in medium- or high-~~stressed~~depleted basins, a ratio of at least 2:1 is recommended. In other words, for every gallon of new water demand projected for development, redevelopment or expansion projects, the goal should be saving or retaining at least two gallons in the basin where the water is being withdrawn.

While water conservation measures, i.e., retrofits of public buildings and older residences with low-flow toilets, showerheads and faucet aerators, have been the primary currency of Massachusetts' water banking programs to date, there are a variety of other techniques that can be used. These can return water or prevent water loss in the basin, such as reduced infiltration and inflow, recharge of stormwater, and retrofit of existing development using low-impact development (LID) principles. Additional capacity can also be gained through groundwater recharge of locally treated wastewater formerly exported out of the basin, and through reuse of grey water.

There are also a host of water conservation measures – such as rebate programs for high-efficiency plumbing fixtures and appliances, xeriscaping, and installation of rainwater collection systems – that can be ~~utilized~~used in a water-banking program. ~~The bank can be structured I/I mitigation that many~~Many communities ~~are~~ now ~~requiring~~ require infiltration/inflow (I/I) mitigation for both new and redevelopment projects~~. Ratios ranging~~, and a water bank can be set up in a similar way. Due to the difficulty of accurately measuring and ensuring the longevity of I/I reductions, ratios of estimated I/I reduction to unit of new water demand typically range from 4:1 to 10:1 ~~are typical. This~~in I/I mitigation programs. These programs can help to create capacity~~,~~ or ~~to~~ fulfill regulatory requirements for regional wastewater systems. The work can be performed either by the developer, or a fee can be charged and the I/I can be removed by the municipality's DPW. A water bank can also be structured to include market mechanisms in which those seeking new or increased water use could buy credits previously banked in excess of the 2:1 ratio in lieu of performing the work themselves. A water bank ~~could also~~can involve multiple towns or be organized on a regional or watershed basis.

If a municipality opts to charge a per gallon fee, either to perform the work itself, or to contract it out, the fees should be deposited in a dedicated enterprise fund and used solely to accomplish the offset measures, and to fund the program's administrative expenses. However, adequate documentation is critical for tracking and reporting on the measures to ensure that the savings are in fact being achieved. Documentation, review and verification by the municipal department or the public water supplier administering the program assures that the work has been performed.

CASE STUDY - Town of ~~Weymouth's~~Acton's Water ~~Banking Program~~ Neutral Growth Initiatives

~~The Town of Weymouth developed a successful water banking program that has enabled it to stay within its authorized withdrawal volume. The bank saved the town 1.2 mgd (million gallons a day) and has helped the town to accommodate new growth and water demand, and to implement an aggressive water conservation program.~~

~~Weymouth's Water Use Permit Program, administered by its DPW, applies to new customers and existing ones seeking to increase water use, for example through the addition of a bedroom or a commercial process. It requires that for every gallon of new demand, two gallons of water, i.e. a 2:1 water savings be achieved. Projected water use is based on Title 5 flows.~~

~~The DPW developed guidelines on water saved by various low-flow household devices and a list of older businesses and residences suitable for installation, or retrofitting. Originally, permit applicants were responsible for doing the residential retrofits, or in the case of businesses, modifying water use practices and processes to create the required savings. However, in 2000, the program was expanded to give applicants the option of paying a $10.00 per gallon mitigation fee to compensate the town for performing the work.~~

~~The mitigation fee, based on cost per gallon to perform the work, including administration costs, is held in a dedicated enterprise Water Conservation Fund, which the Water Department uses to achieve the requisite mitigation. Water savings in excess of 2:1 savings are "deposited" in the water bank for the Town's use.~~

~~While affordable housing developments under M.G.L. c. 40B are subject to the fee, there is a hardship exemption available for individual homeowners. The Fund has also been used to install rain sensors on automatic irrigation systems. The program has not had a negative impact on development, which remains robust in Weymouth.~~

The Town of Acton is protecting its water balance through several mechanisms. The town's groundwater protection overlay district within the zoning bylaw and wetlands bylaw require that all new development document that post-construction conditions represent no net loss of groundwater recharge relative to pre-construction conditions. Note, the MA Wetlands Protection Act already requires this safeguard for all new development on land jurisdictional under the Act, but Acton's bylaws extend this requirement town-wide. Acton's bylaws also require a 50-foot natural buffer and a 75-foot no-development zone around wetlands, further protecting water quality and recharge. In addition to these town bylaws affecting all new development in Acton, the Water District requires certain development projects to offset their water demands through either direct mitigation efforts or by contributing mitigation fees into a fund dedicated to water demand offset projects.[77]

CASE STUDY – Town of Danvers, Program to Offset New Water Demand

The town of Danvers established a Water Use Mitigation Program (WUMP) in 2009 to offset water demand from new development. Projects that produce new or increased water demand pay an impact fee. The fee is based on the calculated cost to remove two gallons of water from the town's water system for every gallon of water that the project adds to the system. The WUMP fee applies to residential projects with three or more dwelling units and all commercial projects. In addition, these projects must use water- and energy efficient plumbing fixtures and appliances. The program also requires any in-ground irrigation systems to include a rain- and moisture-sensing device.

Danvers uses program fees to reduce water demand by offering rebates and implementing conservation measures. The water conservation program in Danvers has several components. Rebates are offered to Danvers residents for upgrades to more efficient water-using products, including toilets, clothes washers, showerheads, and faucets, as well as rain sensors. In addition, rebates are offered to commercial and municipal facilities. Rain barrels are offered to residents, and the program helped fund the rain water reuse system at Danvers High School. Leak detection and leak repairs, both on the system and in homes and businesses, are also important components of the conservation program. For 2018, in addition to offering water-use audits to large water users in the commercial sector, the town plans to identify opportunities to assist commercial customers in reducing the use of water for irrigation.

[77] See the Acton Water District's rules and regulations at: http://www.actonwater.com/assets/media/documents/AWD%20Rules%20and%20Regs%20Revised%2004.26.2016.pdf

Since the program's inception, Danvers has collected impact fees totaling nearly a million dollars, has processed approximately 2,000 rebates, and has estimated water savings ranging from 1.07 to 2.5 million gallons annually.

The Danvers WUMP policy and fee calculation forms can be found on the Danvers Department of Public Works website at https://www.danversma.gov/water-use-mitigation-program-wump/.

B) Model Bylaws[78]

This appendix contains information about – and links to – examples of local bylaws and/or model bylaws that can be used to provide structure and legal mechanisms to implement certain elements of the Water Conservation Standards.

1. BYLAWS ADDRESSING PRIVATE WELLS

~~Falmouth, Article 17, section 223-4~~***Falmouth***, Article 17, section 223-4 pertains to the Board of Selectmen's authority to declare a state of water supply conservation and provides in pertinent part as follows: *However, if the Board of Selectmen makes a specific finding that the shortage of water exists because of a clear and imminent threat to the sole source aquifer underlying Falmouth, such threats to include severe drought, environmental pollution or salt water intrusion, the restrictions adopted pursuant to Section 223-5 shall apply to all citizens, water users, and consumers regardless of the source of water supply.*

Hamilton, Chapter 25: The purpose of this By-law is to protect, preserve and maintain the public health, safety and welfare by creating a balance between the needs of the environment, our ground water supply, the citizens of Hamilton and Hamilton's public water distribution system, and by addressing concerns about lower ground water levels and the potential demand on its water sources during the dry summer months, while recognizing the therapeutic, esthetic and environmental benefits that gardening and landscaping bring to our community. The provisions of this By-law are applicable only to the use of water supplied by the Town's public water system or withdrawn from the same water sources as the Town's public water system and do not apply to the use of recycled water, storm water run-off, gray water or water from cisterns or rain barrels that derive their water directly from precipitation. For the full bylaw, click here.

Topsfield, Chapter 57, Section 58-2.3 pertains to the definition of "water users" in the town, specifically including users who obtain water from a source other than the public water supply: Water Users shall mean all persons, regardless of their geographic location, using water withdrawn from water sources located within the Town of Topsfield.

> Topsfield, Chapter 57, Section 58-2.5 outlines the water conservation measures to be applied to water customers on the town public supply or all water users, including private wells: A declaration of a State of Water Supply Conservation shall specify one or more of the following conservation measures and shall specify whether the measure(s) are voluntary or mandatory and whether the measure(s) apply to water customers only or to all water users. For the full bylaw, click here.

Wenham, Chapter 21, Section 3 defines "water users" in the town, to specifically also include private well users as water users subject to water restrictions: Water Users or Water Consumers shall mean all public and private users of the Town of Wenham's public water system, and/or of groundwater within the borders of the Town of Wenham and extracted from the Ipswich River Watershed. The restrictions shall apply to all water used in the town of Wenham, to include Town water and water supplied by private wells, irrespective of any person's responsibility for billing purposes for water used at any particular

[78] The information in this appendix is based on research conducted by staff and by Gabby Queenan from the Massachusetts Rivers Alliance.

facility. Seasonal Restrictions shall prohibit outdoor watering through a sprinkler or lawn irrigation system between the hours of 9 am to 5 pm between May 1 and September 30 of each year using town water or private well water. For the full bylaw, click here.

Wrentham, Article 6.30, Section 4 on *Water Use Restrictions* pertains to water use restrictions on all water users, including private well users, during a "State of Water Supply Conservation" or a "State of Water Supply Emergency". "All users of the public water supply system of the Town of Wrentham and private well users within the Town of Wrentham shall be subject to this bylaw. This bylaw shall be in effect year round." For the full bylaw, click here.

2. MASSDEP OUTDOOR WATER USE MODEL BYLAW/ORDINANCE:

~~Web page: http://www.mass.gov/dep/water/laws/policies.htm#wmgt~~
~~Direct link to document: http://www.mass.gov/dep/water/laws/modowubl.pdf~~
http://www.mass.gov/eea/agencies/massdep/water/regulations/model-water-use-restriction-bylaw-ordinance.html

3. EXAMPLES OF LAND USE PLANNING BYLAWS/ORDINANCES THAT HELP REDUCE THE NEED FOR WATERING:

Devens Enterprise Commission: Site Plan requirements and design standards in 978 CMR 3.00: http://www.devensec.com/rules-regs/decregstoc.html

Cape Cod Commission Model Land Clearing, Grading and Protection of Specimen Trees Bylaw: http://www.capecodcommission.org/index.php?id=154&maincatid=21

~~3. Massachusetts General Law establishing fines and penalties for water theft:~~

~~MGL Chapter 165, Section 11: Intentional injury to or interference with meter; penalty~~

~~Whoever unlawfully and intentionally injures, or suffers to be injured, a water meter belonging to a city, town, district, or company engaged in supplying water, or prevents such meter from duly registering the quantity of water supplied through it, or hinders or interferes with its proper action or just registration, or attaches a pipe to a main or pipe belonging to a city, town, district or water company, or otherwise uses or causes to be used the water supplied by a city, town, district or company without the consent of the same, unless it passes through a meter set by such city, town, district or company, shall be punished by a fine of triple the amount of damages sustained thereby or $1,000, whichever is greater or by imprisonment for not more than one year, or both. Damages shall include the value of the water used and the cost of labor and equipment repair and replacement.~~

~~4. Bylaw to establish a fine for unauthorized use of a fire hydrant (East Bridgewater)~~

- ~~Article 25, Part Three- Offenses and Penalties of the Town By-Laws and Unauthorized Use of Fire Hydrant (http://www.lawlib.state.ma.us/docs/EastBridgewaterBylaws.pdf)~~
  - ~~Any person, other than an employee of the town performing municipal services, taking or using water from a Town fire hydrant without the prior written consent of the Board of Water Commissioners shall pay to the town a fine in the amount of three hundred dollars ($300.00) for each such offense. The fine may be enforced criminally or non-criminally in the manner set forth in Article XVI.~~

- Any person taking or using municipal water from a Town fire hydrant shall be liable for any damage caused by such action including, but not limited to, damage to any fire hydrant, water main or connection.

5. Water-wise/Water efficient/Native landscaping bylaws from Massachusetts and other states:
   - Massachusetts
     http://www.greenscapes.org/
   - Arizona
     http://www.ci.gilbert.az.us/ordinances/waterconservation.cfm
   - California
     http://www.co.marin.ca.us/depts/CD/Forms/00000067.pdf
   - Colorado
     Water-Efficient Landscape Design: A model landscape ordinance
   - Florida
     http://sarasota.ifas.ufl.edu/Hort/WEL/ord/docs/ord.htm
   - Nevada
     http://www.snwa.com/land/landscapes.html

~~This page intentionally left blank~~

Model bylaws/ordinances for Low-Impact Development and Open Space Design/Natural Resource Protection Zoning: http://www.mass.gov/envir/smart_growth_toolkit/index.html

C) ~~Education and Outreach Materials~~

Example Water Bill ~~Inserts:~~ Insert

Courtesy, Sharon Water Department

OUR REBATE PROGRAM

Get a $100 credit on your water bill for installing a high-efficiency toilet!

Get a $200 credit on your water bill for installing a front load washing machine!

These advanced devices deliver many benefits. They reduce your water bill and may extend the life of your septic system.

Gallons Per Capita Daily (GPCD) Lookup Table*

GALLONS USED IN 6 MONTHS (for annual GPCD, average your last two water bills)	NO. OF HOUSEHOLD OCCUPANTS							
	1	2	3	4	5	6	7	8
4,000	22	11	7	5	4	4	3	3
6,000	33	16	11	8	7	5	5	4
8,000	44	22	15	11	9	7	6	5
10,000	55	27	18	14	11	9	8	7
12,000	66	33	22	16	13	11	9	8
14,000	77	38	26	19	15	13	11	10
16,000	88	44	29	22	18	15	13	11
18,000	99	49	33	25	20	16	14	12
20,000	110	55	37	27	22	18	16	14
22,000	121	60	40	30	24	20	17	15
24,000	132	66	44	33	26	22	19	16
26,000	142	71	47	36	28	24	20	18
28,000	153	77	51	38	31	26	22	19
30,000	164	82	55	41	33	27	23	21
32,000	175	88	58	44	35	29	25	22
34,000	186	93	62	47	37	31	27	23
36,000	197	99	66	49	39	33	28	25
38,000	208	104	69	52	42	35	30	26
40,000	219	110	73	55	44	37	31	27
42,000	230	115	77	58	46	38	33	29
44,000	241	121	80	60	48	40	34	30
46,000	252	126	84	63	50	42	36	32
48,000	263	132	88	66	53	44	38	33
50,000	274	137	91	68	55	46	39	34
52,000	285	142	95	71	57	47	41	36
54,000	296	148	99	74	59	49	42	37
56,000	307	153	102	77	61	51	44	38
58,000	318	159	106	79	64	53	45	40
60,000	329	164	110	82	66	55	47	41
62,000	340	170	113	85	68	57	49	42
64,000	351	175	117	88	70	58	50	44
66,000	362	181	121	90	72	60	52	45
68,000	373	186	124	93	75	62	53	47
70,000	384	192	128	96	77	64	55	48
72,000	395	197	132	99	79	66	56	49
75,000	411	205	137	103	82	68	59	51
80,000	438	219	146	110	88	73	63	55
85,000	466	233	155	116	93	78	67	58
90,000	493	247	164	123	99	82	70	62
95,000	521	260	174	130	104	87	74	65
100,000	548	274	183	137	110	91	78	68

**The state water use planning goal for Massachusetts is 65 GPCD.*

Save Water! Save Money!

Get Valuable Rebates

for installing

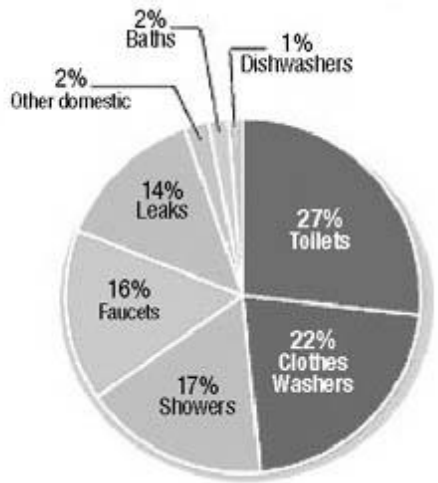
High-Efficiency Toilets

and

Washing Machines

Sharon Water Department
and
Water Management Advisory Committee

Toilets and clothes washers are the top two indoor water guzzlers in a typical home*:



High-efficiency toilets and front load clothes washers help keep your water use under **65 GPCD** (see the handy GPCD lookup table on the reverse to find out your water use). Thanks to innovative engineering, they also function better than older models.

*Sources: American Water Works Association and AWWA Research Foundation

TOILET TIPS

- Install advanced High Efficiency Toilets (HETs) that average less than 1.3 gallons per flush. HETs are powerful and less prone to overflow. HETs may save 15,000 gallons per year compared to old 3.5 gallon models.
- Avoid flushing the toilet when not absolutely necessary, and don't use your toilet as a wastebasket.
- Toilet leaks cause high water bills. Check for toilet leaks by putting food coloring in your toilet tank. Do not flush. If dye appears in the bowl within 10-15 minutes, check the flapper in your toilet tank to see if it has deteriorated and needs to be replaced.
- Don't put strong cleaning chemicals in your toilet tank. They may corrode the rubber and plastic parts in your toilet tank and cause leaks.

FRONT LOAD WASHERS

Front load washing machines use less than 15 gallons per load, far less than the 35 to 50 gallons per load used by older top load models, and may save 10,000 gallons per year.

Front-load washing machines:

- Conserve heated water and lower your energy bills.
- Wring out more moisture in the spin cycle, reducing drying time and energy costs.
- Decrease wear on clothes so they last longer.
- Require less detergent.
- Help extend the life of your septic system.

OUR REBATE PROGRAM

Get a $100 credit on your water bill for installing a high-efficiency toilet!

Get a $200 credit on your water bill for installing a front load washing machine!

These advanced devices deliver many benefits. They reduce your water bill and may extend the life of your septic system.

Gallons Per Capita Daily (GPCD) Lookup Table*

GALLONS USED IN 6 MONTHS (for annual GPCD, average your last two water bills)	NO. OF HOUSEHOLD OCCUPANTS							
	1	2	3	4	5	6	7	8
4,000	22	11	7	5	4	4	3	3
6,000	33	16	11	8	7	5	5	4
8,000	44	22	15	11	9	7	6	5
10,000	55	27	18	14	11	9	8	7
12,000	66	33	22	16	13	11	9	8
14,000	77	38	26	19	15	13	11	10
16,000	88	44	29	22	18	15	13	11
18,000	99	49	33	25	20	16	14	12
20,000	110	55	37	27	22	18	16	14
22,000	121	60	40	30	24	20	17	15
24,000	132	66	44	33	26	22	19	16
26,000	142	71	47	36	28	24	20	18
28,000	153	77	51	38	31	26	22	19
30,000	164	82	55	41	33	27	23	21
32,000	175	88	58	44	35	29	25	22
34,000	186	93	62	47	37	31	27	23
36,000	197	99	66	49	39	33	28	25
38,000	208	104	69	52	42	35	30	26
40,000	219	110	73	55	44	37	31	27
42,000	230	115	77	58	46	38	33	29
44,000	241	121	80	60	48	40	34	30
46,000	252	126	84	63	50	42	36	32
48,000	263	132	88	66	53	44	38	33
50,000	274	137	91	68	55	46	39	34
52,000	285	142	95	71	57	47	41	36
54,000	296	148	99	74	59	49	42	37
56,000	307	153	102	77	61	51	44	38
58,000	318	159	106	79	64	53	45	40
60,000	329	164	110	82	66	55	47	41
62,000	340	170	113	85	68	57	49	42
64,000	351	175	117	88	70	58	50	44
66,000	362	181	121	90	72	60	52	45
68,000	373	186	124	93	75	62	53	47
70,000	384	192	128	96	77	64	55	48
72,000	395	197	132	99	79	66	56	49
75,000	411	205	137	103	82	68	59	51
80,000	438	219	146	110	88	73	63	55
85,000	466	233	155	116	93	78	67	58
90,000	493	247	164	123	99	82	70	62
95,000	521	260	174	130	104	87	74	65
100,000	548	274	183	137	110	91	78	68

**The state water use planning goal for Massachusetts is 65 GPCD.*

Save Water! Save Money!

Get Valuable Rebates

for installing

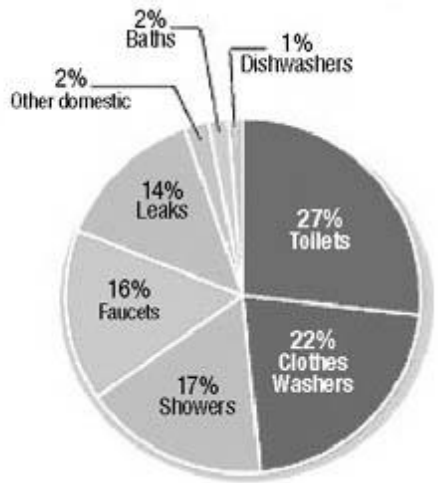
High-Efficiency Toilets

and

Washing Machines

Sharon Water Department
and
Water Management Advisory Committee

Toilets and clothes washers are the top two indoor water guzzlers in a typical home*:



High-efficiency toilets and front load clothes washers help keep your water use under **65 GPCD** (see the handy GPCD lookup table on the reverse to find out your water use). Thanks to innovative engineering, they also function better than older models.

*Sources: American Water Works Association and AWWA Research Foundation

TOILET TIPS

- Install advanced High Efficiency Toilets (HETs) that average less than 1.3 gallons per flush. HETs are powerful and less prone to overflow. HETs may save 15,000 gallons per year compared to old 3.5 gallon models.
- Avoid flushing the toilet when not absolutely necessary, and don't use your toilet as a wastebasket.
- Toilet leaks cause high water bills. Check for toilet leaks by putting food coloring in your toilet tank. Do not flush. If dye appears in the bowl within 10-15 minutes, check the flapper in your toilet tank to see if it has deteriorated and needs to be replaced.
- Don't put strong cleaning chemicals in your toilet tank. They may corrode the rubber and plastic parts in your toilet tank and cause leaks.

FRONT LOAD WASHERS

Front load washing machines use less than 15 gallons per load, far less than the 35 to 50 gallons per load used by older top load models, and may save 10,000 gallons per year.

Front-load washing machines:

- Conserve heated water and lower your energy bills.
- Wring out more moisture in the spin cycle, reducing drying time and energy costs.
- Decrease wear on clothes so they last longer.
- Require less detergent.
- Help extend the life of your septic system.

D) ~~*Plumbing Fixtures and Appliances: Water-Use Data and Water-Use*~~ Improvements in Household Water Efficiency and Standards

~~**Table 1. Average indoor water use in nonconserving and conserving North American single-family homes**~~

~~Water Use Type~~	~~Nonconserving Home*~~	~~Conserving Home 2001*~~	~~Conserving Home 2005**~~	~~Nonconserving Home~~	~~Conserving Home 2001~~	~~Conserving Home 2005~~
~~*Units*~~	~~*Average gpcd*~~	~~*Average gpcd*~~	~~*Average gpcd*~~	~~*Percent of total*~~	~~*Percent of total*~~	~~*Percent of total*~~
~~Dishwasher~~	~~1~~	~~0.7~~	~~0.7~~	~~1.4%~~	~~1.5%~~	~~1.9%~~
~~Baths~~	~~1.2~~	~~1.2~~	~~1.2~~	~~1.7%~~	~~2.7%~~	~~3.3%~~
~~Leaks~~	~~9.5~~	~~4~~	~~4.0~~	~~13.7%~~	~~8.8%~~	~~11.0%~~
~~Faucets~~	~~10.9~~	~~10.8~~	~~10.8~~	~~15.7%~~	~~23.9%~~	~~29.8%~~
~~Showers~~	~~11.6~~	~~8.8~~	~~7.0~~	~~16.8%~~	~~19.5%~~	~~19.4%~~
~~Clothes Washer~~	~~15~~	~~10~~	~~5.2~~	~~21.7%~~	~~22.1%~~	~~14.3%~~
~~Toilets~~	~~18.5~~	~~8.2~~	~~5.6~~	~~26.7%~~	~~18.0%~~	~~15.6%~~
~~Other Domestic~~	~~1.6~~	~~1.6~~	~~1.6~~	~~2.2%~~	~~3.4%~~	~~4.4%~~
~~**TOTAL**~~	~~**69.3 gpcd**~~	~~**45.2 gpcd**~~	~~**36.2 gpcd**~~	~~**100%**~~	~~**100%**~~	~~**100%**~~

~~**Source: Vickers, 2001 (Adapted from Mayer et al, 1999)*~~

~~***Substituting 1.1 gpf High Efficiency Toilets, a 14 gpl front-load washing machine, and 2.0 gpm showerheads for Vickers' 1.6 gpf toilets, 27 gpl washing machine and 2.5 gpm showerheads*~~

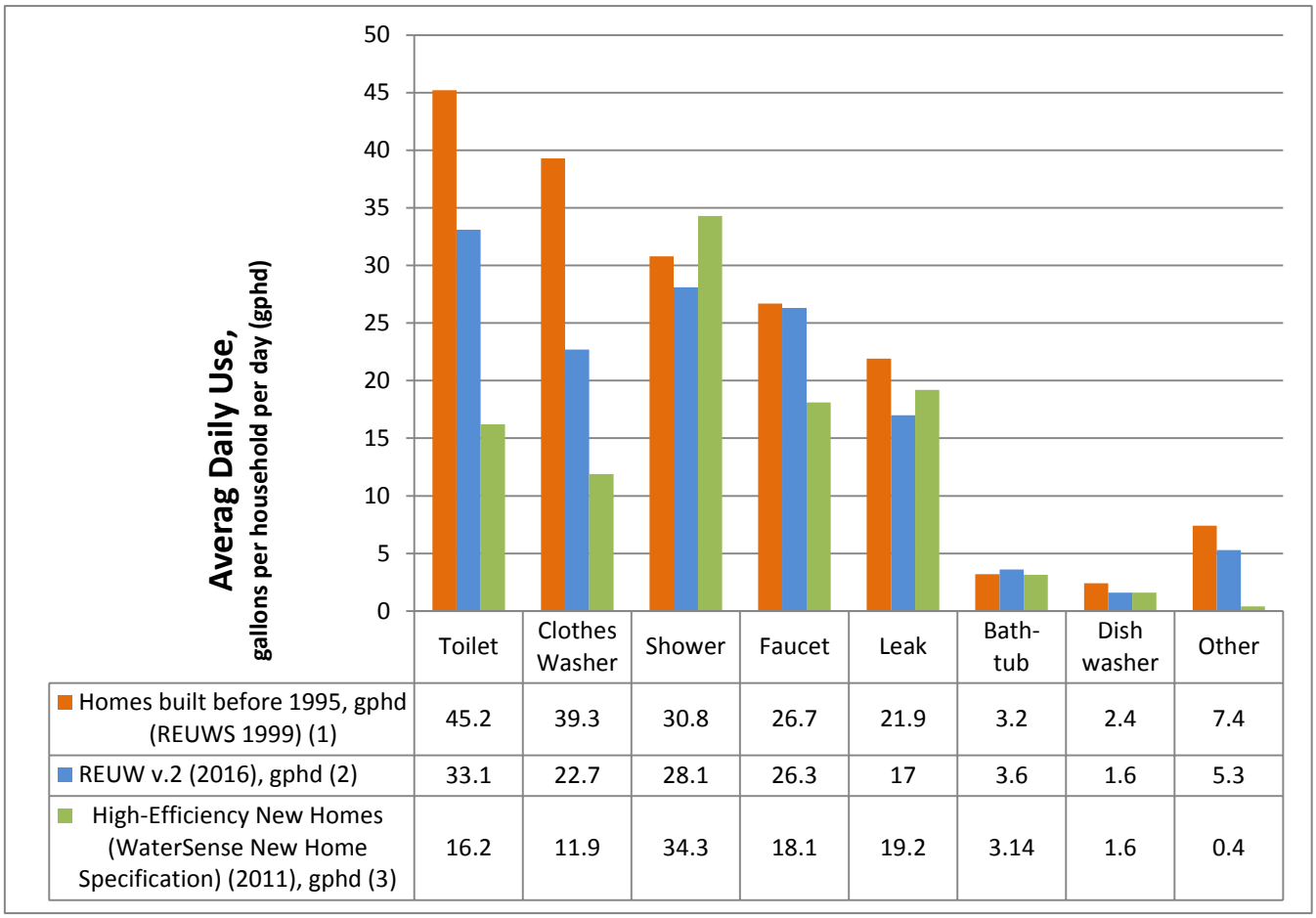
~~gpcd = gallons per capita daily, gpf=gallons per flush, gpl=gallons per load, and gpm=gallons per minute~~

~~To find out how much water you use, try~~

Since 1992, average total household water use in Massachusetts and across the United States has declined. Figure D-1 shows how **the installation of high-efficiency plumbing fixtures and appliances has contributed to water savings** in North America over the past twenty-five years. Significant water savings result from the installation of high-efficiency toilets and clothes washers. Table D-1 compares flow rates of older fixtures and appliances with flow rates in high-efficiency homes.

How much water do you use? Try the **Home Water Works Calculator** at **http://www.home-water-works.org/calculator**~~.~~

Figure D-1. Indoor Water Use, Single-Family Homes in North America



	Toilet	Clothes Washer	Shower	Faucet	Leak	Bath-tub	Dish washer	Other
Homes built before 1995, gphd (REUWS 1999) (1)	45.2	39.3	30.8	26.7	21.9	3.2	2.4	7.4
REUW v.2 (2016), gphd (2)	33.1	22.7	28.1	26.3	17	3.6	1.6	5.3
High-Efficiency New Homes (WaterSense New Home Specification) (2011), gphd (3)	16.2	11.9	34.3	18.1	19.2	3.14	1.6	0.4

Sources:~~**Table 2. Federal and Massachusetts water-use standards for plumbing fixtures and selected appliances**~~

(1) Residential End Uses of Water Study (REUWS) (Mayer et al. 1999). Analysis of water consumption by end uses (residential plumbing fixtures and appliances) in 1,188 single-family homes in 12 North American cities. Data collected 1996 to 1998. REUWS data were later normalized to a family of 3 in the REUWS2 study (see Note 2).

(2) DeOreo, W., P. Mayer, B. Dziegielewski, and J. Kiefer. 2016. Residential end uses of water, version 2. Denver: Water Research Foundation.

(3) DeOreo, William B. 2011. Analysis of Water Use in New Single-Family Homes. Boulder, CO: Aquacraft Water Engineering and Management. Measures water use in 25 new homes built using criteria equivalent to the WaterSense New Home Specification or better.

Table D-1. Average Flow Rates in Residential End Uses of Water Studies

~~Fixture or Appliance~~	~~Standard (Federal and MA)~~
~~Toilets~~	~~1.6 gpf~~
~~Urinals, Residential and Commercial~~	~~1.0 gpf~~
~~Showerheads, Residential~~	~~2.5 gpm (at 80 psi)~~
~~Lavatory faucets and replacement aerators, Residential~~ ~~Kitchen faucets and replacement aerators, Residential~~	~~2.2 gpm (at 60 psi)~~
~~Faucets, Commercial~~	~~Private* faucets: 2.2gpm at 60 psi~~ ~~Public restroom faucets: 0.5 gpm at 60 psi~~ ~~Metering (auto shut-off) faucets: 0.25 gpc~~
~~Dishwashers, Residential~~	~~Standard models: Water Factor of 6.5 gpc or less~~ ~~Compact size: WF of 4.5 gpc or less~~

	Toilet (gal. per flush)	Clothes ~~Washers, Residential and Commercial (Family-sized~~Washer (gal. per load)	~~Water Factor of 9.5 gpc/ft³ or less~~ Shower (gal. per min.)
Homes built before 1995 (REUWS1) (measured flow rates)	3.48	40.9	2.22
High-Efficiency New Homes (flow rates based on WaterSense specifications)	1.28	15	1.6

Water-Use Standards

Table D-2 lists water-use standards currently in effect through codes as well as the higher efficiency standards available to consumers who select WaterSense-labeled plumbing fixtures and Energy Star-labeled appliances.

How much water would you save by upgrading to more efficient fixtures? Try the WaterSense calculator at https://www.epa.gov/watersense/watersense-calculator.

Table D-2. Water-Use Standards for Selected Plumbing Fixtures and Appliances

Fixture or Appliance	Federal and MA Water-Use Standard[79]	WaterSense or Energy Star Standard
Toilets	1.6 gpf	≤1.28 gpf
Urinals, residential & commercial	1.0 gpf	≤0.5 gpf
Showerheads, residential	2.5 gpm at 80 psi	2.0 gpm maximum[1]
Lavatory faucets & replacement aerators, residential	2.2 gpm at 60 psi	1.5 gpm at 60 psi, max. & 0.8 gpm at 20 psi min.
Kitchen faucets & replacement	2.2 gpm at 60 psi	no standard

[79] Federal regulations: 10 CFR Part 430.32. Massachusetts Uniform State Plumbing Code: 248 CMR 10.

aerators, residential			
Faucets, commercial	Private[2]: 2.2gpm at 60 psi Public restroom: 0.5 gpm at 60 psi Metering (auto shut-off): 0.25 gpc	no standard	
Clothes Washers, residential (standard size) [3] Top-loading: Front-loading:	6.5 IWF 4.7 IWF	Current: 4.3 IWF 4.4 3.7 IWF	as of 2/5/18: 4.3 IWF 3.2 IWF
Dishwashers, residential	Standard: 5.0 gpc or less Compact: 3.5 gpc or less	Standard: 3.5 gpc or less Compact: 3.5 gpc or less	

gpc = gallons per cycle
gpf = gallons per flush
gpl = gallons per load
~~gpl = gallons per load~~
gpm = gallons per minute
IWF = Integrated Water Factor (gallons/cycle/cubic foot)
psi = pounds per square inch

~~WF = Water Factor, a measure of the gallons of water used per cycle per cubic foot~~

~~*~~

1. The WaterSense specification for showerheads also includes standards for spray force and coverage.
2. "Private" defined as residential, hotel guest rooms, and health care patient rooms.
3. New, more efficient federal standards for clothes washers went into effect on January 1, 2018, and include standards for compact as well as standard-size clothes washers. See 10 CFR 430.32(g). Updated Energy Star standards (Version 8.0) for clothes washers will go into effect on February 5, 2018 (https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Final%20Version%208.0%20Clothes%20Washer%20Partner%20Commitments%20and%20Eligibility%20Criteria.pdf).
4. See also Energy Star, http://www.energystar.gov/index.cfm?c=clotheswash.pr_crit_clothes_washers. For products with even greater efficiency, see the Consortium for Energy Efficiency's (CEE) Super Efficient Home Appliances Initiative at https://library.cee1.org/content/cee-super-efficient-home-appliance-initiative-january-2016/. The Energy Star criteria for dishwashers became effective January 29, 2016.

~~Sources:~~ ~~Adapted from Vickers, 2001; Alliance for Water Efficiency, August 2011~~
~~References: Energy Policy Act of 1992, Energy Policy Act of 2005, Energy Independence and Security Act of 2007, National Appliance Energy Conservation Act, MA Plumbing Code~~

E) Residential Water-Use Data and Benchmarks

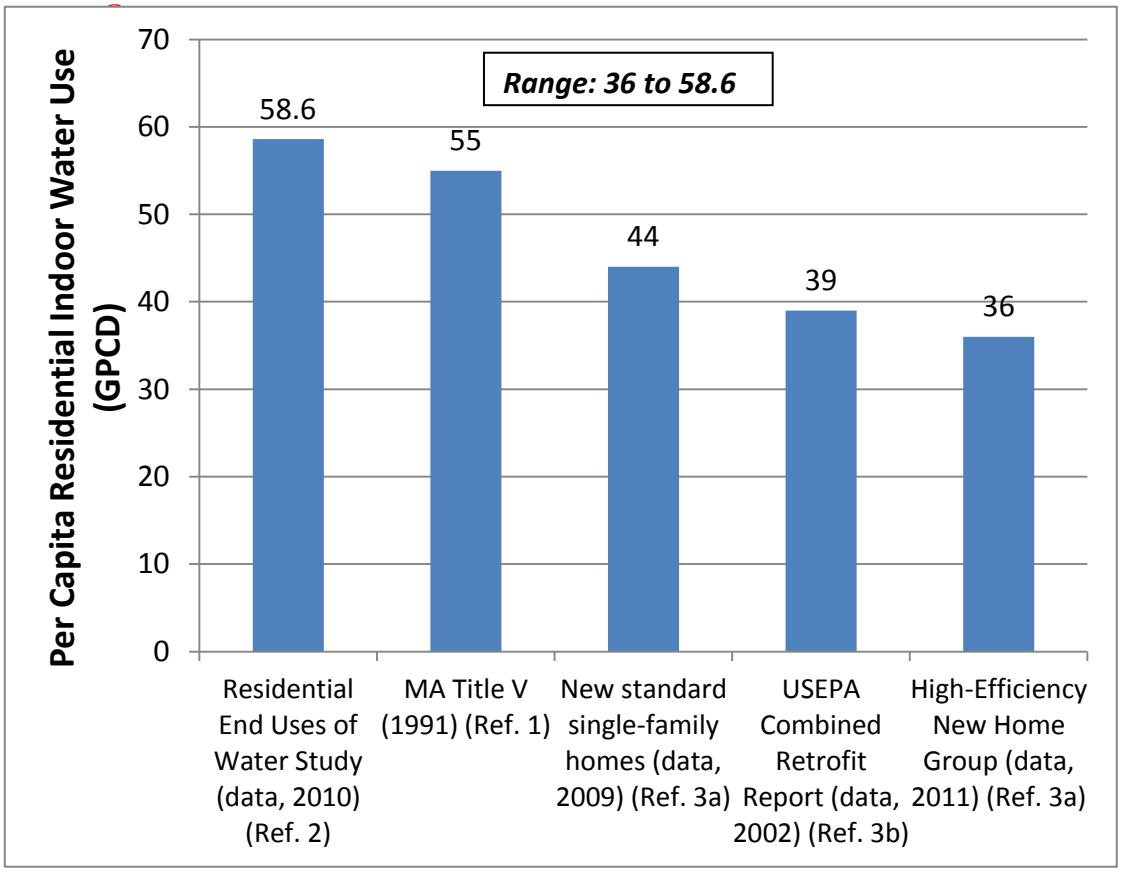
~~The following discussion presents residential water-use numbers, including state, national, and international data, to provide the reader with some context and background for how the residential water-use efficiency benchmarks were developed.~~

The amount of water consumed by a residential population is commonly used as a benchmark to evaluate the success of water conservation efforts. Water use is typically measured in gallons~~,~~ and reported as gallons per capita per day (gpcd~~) that includes~~), representing both indoor and outdoor water use for ~~a single residence~~an individual. Measured and estimated numbers for residential gpcd vary throughout the state, the country, and the world. ~~In a survey of average combined indoor and outdoor residential water use for 13 cities and the United Kingdom, Vickers reports a low of below 50 gpcd for Cairo, Egypt, and the United Kingdom, and a high of over 200 gpcd for Phoenix, Arizona, and Las Virgenes, California.~~

Data considered in developing and evaluating benchmarks for efficient residential water use in Massachusetts are presented below, along with several theoretical water budget scenarios.
Note: all numbers are residential gallons per capita per day (rgpcd) unless otherwise noted.

INDOOR WATER USE

- ~~Vickers[1]: US avg. = 69~~
- ~~REUWS[2]: 12 cities, 1,188 homes, predominantly west and southwest Avg. = 60~~
- ~~Maddaus[3]: US Avg. = 60~~
- ~~MA Title 5 wastewater modeling assumptions[4]: Avg. wastewater flow = 55~~
- ~~Seattle Home Water Conservation Study[5]: Avg. = 45~~
- ~~*Range: 45 to 69*~~



Base indoor water use does not vary significantly over the year or across the country and continues to go down on average. ~~Base indoor water use typically constitutes the majority of total water use even in summer months.~~ Improvements in base indoor water use efficiency help reduce water use in summer when it matters the most.

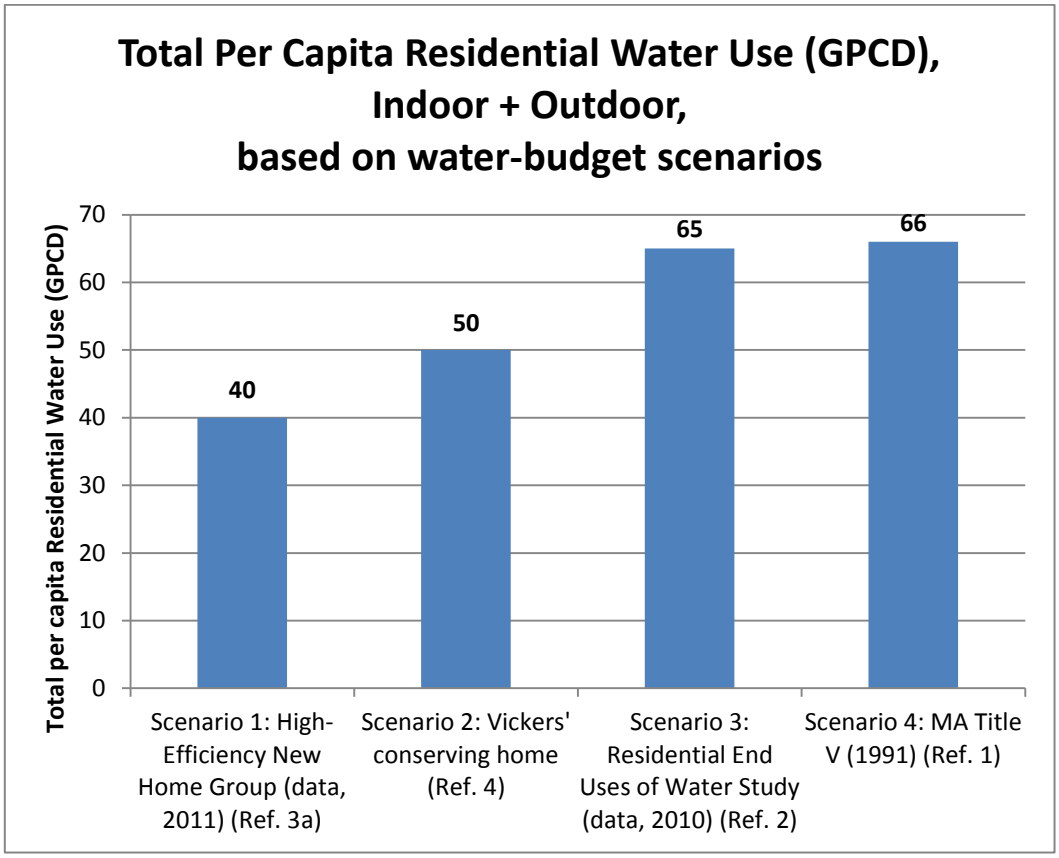
OUTDOOR WATER USE

- ~~Vickers: US avg. = 32~~
- ~~REUWS: Avg. = 101~~
- ~~Full Conservation: close to zero~~
- ~~*Range: zero to 101*~~

~~*Comments:*~~ *Outdoor water use varies significantly over the year and across the country and has been going up on average. In New England, outdoor water use during the months of May through September typically increases by approximately 25~~ *% to 50% over base indoor use from November through March.*[80]

THEORETICAL WATER BUDGET SCENARIOS

Following are some residential water-use scenarios that were considered in developing annual water consumption benchmarks:



Scenario 1: ~~*Full Conservation 2005*~~ *High-Efficiency New Homes (Reference #3a)*
~~*Assumes fully conserving fixtures and appliances available in 2005*~~*Assumes homes meeting the WaterSense new home specification (as of 2009) and high-efficiency Energy Star-rated clothes washer, for indoor use, and 25% increase over base for outdoor use*

[80] The peak irrigation season is typically between June and August

Assume 36 for indoor (months of October through April)
Assume 45 during the months of May through September (36 indoor + 25% increase over base)
Annual avg. = 40 gpcd

Scenario 2: Full Conservation 2001 (Reference #4, Figure 2.4)
Vickers' conserving household numbers ~~published in 2001~~ for indoor use, and 25% increase over base for outdoor use

Assume 45 for indoor (months of October through April)
Assume 56 during the months of May through September (45 indoor + 25% increase over base)
Annual avg. = 50 gpcd

Scenario 3: ~~Massachusetts~~U.S. Average 2010 (Reference #2)
Updated Residential End Uses of Water Study numbers for average indoor use and 25% increase over base for outdoor use

Assume 58.6 for indoor (months of October through April)
Assume 73 during the months of May through September (58.6 indoor + 25% increase over base)
Annual avg. = 65 gpcd

Scenario 4: Massachusetts Title 5 1991 (Reference #1)
MA Title 5 numbers for indoor use and 50% increase over base for outdoor use

Assume 55 for indoor (months of October through April)
Assume 82.5 during the months of May through September (55 indoor + 50% increase over base)
Annual avg. = 66 gpcd

~~*Scenario 4: US Average*~~
~~*Vickers numbers for average indoor use and 50% increase over base for outdoor use*~~

~~Assume 69 for indoor (months of October through April)~~
~~Assume 104 during the months of May through September (69 indoor + 50% increase over base)~~
~~**Annual avg. = 84 gpcd**~~

STATUS ~~of~~OF MA COMMUNITIES IN RELATION ~~to~~TO MassDEP ~~BENCHMARKS~~ ~~of~~BENCHMARK OF 65 RGPCD

~~MassDEP, 2008 – 2010 ASRs[6], 280 communities reporting at least one year:~~
- ~~Average = 64 rgpcd~~

~~74 communities or 26% were 66~~MassDEP, 2011 – 2015 ASRs (DEP-accepted values, Ref. #6):
- Average = 58 rgpcd ~~or higher~~
- ~~206 communities or 74~~77% were 65 rgpcd or lower in 2015

Massachusetts Water Resources Authority (MWRA), 2008 – ~~2010, 29~~2012, communities (minus Boston) entirely served by the MWRA:
- Average = 64 rgpcd
- ~~Average = 64 rgpcd~~

~~SOURCES (see~~

REFERENCES

~~**References** for full citations)~~

1. ~~Amy Vickers. 2001. Handbook of Water Use and Conservation.~~

~~2. Mayer et al. 1999. Residential End Uses of Water Study (REUWS)~~

~~3. Maddaus, W.O. 1987. Water Conservation. American Water Works Association. Denver, CO.~~

~~4.~~ MassDEP and DeFeo, Wait & Associates, Inc. 1991. Technical Evaluation – Title 5 the state environmental code, 310 CMR 15.00. Boston, MA: Commonwealth of Massachusetts. ~~Title 5.~~

~~5.~~2. DeOreo, W., P. Mayer~~ et al. 2000. Seattle Home~~, B. Dziegielewski, and J. Kiefer. 2016. Residential end uses of water, version 2. Denver: Water Research Foundation.

3. DeOreo, W.B., and P. Mayer. 2012. Insights into declining sing-family residential water demands. Journal American Water Works Association. 104: E383 – E394. Available at http://www.awwa.org/publications/journal-awwa/abstract/articleid/31472016.aspx. This article compares four key end-use studies, including the following:
   a. DeOreo, W.B. 2011. Analysis of water use in new single-family homes. Report to Salt Lake City Corporation and U.S. EPA. Boulder, CO: Aquacraft.
      - High-efficiency new home group: data collected 2008 and 2009
      - Standard new home group: data collected between 2006 and 2008
   b. Aquacraft. 2005. US EPA—Combined Retrofit Report. Water and Energy Savings from High Efficiency Fixtures and Appliances in Single Family Homes. Boulder, CO: Aquacraft. (Data collected between 2000 and 2002).
4. Vickers, Amy. 2001. Handbook of Water Use and Conservation~~ Study.~~. Amherst, MA: WaterPlow Press. See Figure 2-4
5. Mayer, P.W., W.B. DeOreo, E.M. Opitz, J. C. Kiefer, W.Y. Davis, B. Dziegielewski, and J.O. Nelson. 1999. Residential End Uses of Water. Denver, CO: AWWA Research Foundation and American Water Works Association.
6. MassDEP Public Water Supply Annual Statistical Report Data, ~~2008, 2009, 2010~~2011 – 2015. Email correspondence from Jen D'Urso, MassDEP, January 23, 2017.

F) BMPs for Selected Industries[81]

Water consumption in the Semiconductor, Metal Plating, ~~Printed Circuit Boards,~~ Paper~~ and Rubbers~~, Food and Plastics industries is quite high. Knowledge of water balance for the entire facility and specifications for ~~each stream~~individual streams and processes are useful for a program on water conservation. Simple engineering systems such as countercurrent ~~flows~~rinsing, high-pressure low volume water cleaning, low-volume atomized or fog spray rinsing systems, tying dumping of baths to measurement of critical bath parameters, installing essential instrumentation (e.g. flow restrictors, conductivity controllers, pH meters, etc.) and installing filtration/screening and cooling systems to extend bath life are all options to reclaim, refine, and reuse water continuously.

WATER CONSERVATION PLANS (general)

Water is an important resource or raw material in the manufacturing of various products; however, for many facilities water is usually considered an overhead cost. In most municipalities in the Commonwealth of Massachusetts, facilities pay a contracted rate for the volume of water supplied and a sewer cost, typically at a higher and different rate. To appreciate the contribution of water to the operation of any plant, there should be a cost value assigned to its input, whether it is a ~~reactant, a~~ solvent, ~~a~~ cleaning agent, used for cooling, a convenient means to transport other resources, or a way to store intermediate or final products.

Controlling the use and cost of water is the responsibility of everybody in the company. A policy statement with clear objectives that is supported by top management will define the company's position on water use. The objectives serve as guidelines to develop goals that all employees can work towards. Included in this policy, a management team should be established and a continuous program for educating employees should be implemented.

The management team monitors the use of water in the facility and to formulate an equitable means of allocating cost to the use of water and its disposal. For a small facility, these responsibilities ~~maybe~~may be assigned to an individual with the additional authority to enforce viable and cost-effective changes.

Basic Program

Outlined below are some simple, practical and general measures and procedures that may promote water conservation and optimal uses in some industry sectors. The list is by no means exhaustive. The peculiarities of an individual facility may make some of the suggestions impractical - ideally, such peculiarities should be viewed as opportunities to develop viable alternatives.

Water Budget

Measurements should be taken to establish a water budget for all operations. Inputs and effluents from all processes should be assessed. The flow of water ~~at all points of input and effluent for all process steps~~within the facility should be measured, documented and continuously monitored. Water meters may be installed for ~~major consumers.~~the most significant water uses. Simple methods to estimate flow rates, e.g. using a bucket and a timer, can be adequate to get reasonable flow rates at individual steps in the production process.

Cost Centers

A realistic cost value based on volumes used should be assessed to ~~all~~the most significant process steps. Major consumers may be considered cost centers and the cost to supply water and to dispose of wastewater should be documented regularly.

---

[81] Best Management Practices for Selected Industries and Additional Resources. Gus Ogunbameru, PhD. Ch. E. - Massachusetts Office of Technical Assistance. ~~For more information, see the Water Conservation Publications on the OTA web site.~~
See also the Alliance for Water Efficiency, "Water Saving Tips: Commercial, Industrial, and Institutional Water Use," at http://www.allianceforwaterefficiency.org/CII-tips.aspx

Monitor and Audit

At established periodic intervals, flow rates should be measured and compared with those established through the water balance.

Maintenance

All fresh water and wastewater leaks should be logged on a daily basis. Maintenance should be carried out to fix leaks within 24 hours of their discovery.

Energy Savings

In many operations, water conservation will reduce energy costs as well as water costs.

More Information

For further information on BMPs and case studies on successful water reduction efforts in each of the following industrial sectors, please visit the OTA website at: ~~:~~ ~~http://www.mass.gov/envir/ota/resources/water_conserv.htm~~https://www.mass.gov/how-to/request-water-conservation-and-wastewater-recommendations

- Semiconductors
- Metal Plating
- ~~Printed Circuit Boards~~
- Paper Mills
- Rubber and Plastics

G) Water Conservation Coordinator Job Description

Water conservation coordinators are commonly found in the West and other places frequently plagued with drought conditions. Here in the New England, however, one would be hard pressed to find a water conservation coordinator – even in a large utility.

Some public water suppliers may not see the need to employ a water conservation coordinator. Water is plentiful most times of the year; if demand gets too high in the summer, mandatory restrictions on outdoor water use is usually an effective way to deal with the problem.

However, reacting to emergency situations is not in the long term best interests of the utility and could lead to poor relations with customers. Responsible water suppliers manage water demand to reduce waste and ensure adequate supplies for essential domestic use and fire safety, without restricting customers' use. One way to achieve this goal is to create and implement a comprehensive water conservation program that addresses residential, institutional, and commercial users. To be effective, water conservation must be continuously promoted by all levels of local government over a period of years or even decades to raise the consciousness of the community regarding the importance of responsible, efficient water use.

Public Water Suppliers seriously interested in implementing a comprehensive water conservation effort should hire an individual to create and carry out the conservation program. While some water conservation activities can be added to existing staffs' duties, a program is more likely to succeed when staff is hired specifically to implement conservation programs because:

- A coordinator's sole focus is reducing water use in the community. He or she is able to methodically plan and carry out a water conservation program without the distractions and/or demands of other duties.
- Existing staff may not have the desired skill set of a coordinator

In regards to funding the position, there are several models water suppliers could consider. A large utility may find it necessary to hire at least one full-time person. In other parts of the country, water suppliers have a staff of water conservation specialists. Smaller utilities can hire a water conservation specialist on a part time basis or share one among several towns.

Typical job duties of a water conservation coordinator include the following:

- Establish water conservation goals
- Develop a water conservation program
- Identify and assess conservation incentives appropriate for implementation
- Analyze the costs and benefits of the water conservation program
- Encourage installation of water monitoring infrastructure such as remote meter reading and leak detection systems
- Study various rate structures to encourage water conservation
- Answer public inquiries
- Coordinate with state and federal government
- Design and write water conservation outreach material, including letters to the editor, bill inserts, brochures and web site content
- Create and implement promotional and marketing campaign aimed at achieving water conservation program goals
- Assist residential, commercial and institutional customers in conserving water
- Administer and enforce local water regulations and restrictions
- Conduct presentations at various forums including stakeholder groups, schools, clubs and business associations

G) Sample Worksheet for Industrial / Commercial / Institutional Water Audit[82]

AUDIT COMPLETED BY (NAME): **DATE:**

GENERAL INFORMATION

Customer/Account Name:
Address:
Facility contact person:
Product(s) or services(s):

SIC category(ies)

Facility dimensions (for each building) in sq ft:	No. floors	Width	Height	Age of facility(years)	
Avg. no. of occupants (employees and nonemployees):	Female:	Male	Total		
Avg. no. of days facility occupied/year	Avg. no. hours occupied/day:	Weekdays	Weekends	Holidays	
Is recycled water currently used on site?	Yes	No	If yes, describe and give amount used (e.g. gallons per year):		
Building wastewater is:	Treated on site	Connected to municipal/off-site system	Other (describe)		

METER INFORMATION

	Meter No. 1 ID No.	**Meter No. 2 ID No.**	**Meter No. 3 ID No.**	**Meter No. 4 ID No.**	**Meter No. 5 ID No.**
Meter location					
Meter type					
Reading frequency					
Units of register					
Multiplier (if any)					
Meter size					
Connection size					
Meter installation date					
Testing frequency					
Last service (date)					
Last test/calibration (dates)					

Note: The complete ICI water audit worksheet is five pages and covers an ICI building/facility water-use inventory, recommended efficiency measures, potential water savings from ICI efficiency measures, and potential benefit and costs from ICI efficiency measures. For details, see Vickers 2001, Appendix G.

[82] Source: Vickers, Amy. 2001. *Handbook of water use and conservation.* Amherst, MA: WaterPlow Press.

~~I~~H) Summary of Water Conservation and Water Quality Recommendations for Lawns and Landscapes

SOILS	
Care and Maintenance Components	**Water Conservation Recommendations**
Soil Health	• Ensure adequate depth and type of soil (at least 6 inches of good topsoil). Generally, a sandy loam with 5% organic content is recommended for turf grass and landscapes. The texture, organic content, pH level, drainage, salinity and fertility are important characteristics of soil that should be considered before planting anything. • Aerate the soil. Look for areas where soil may be compacted. • Use peat moss, well-rotted manure, or compost to improve moisture retention. Peat moss must be thoroughly mixed with the soil in order to be effective at improving drainage characteristics. If used as a topdressing or over aeration holes, it can actually wick water away from the soil and roots. Choose manure and composts that are well decomposed. Manure and compost can be a source of weed seeds if not well decomposed. • Use cultural and fertility practices that increase water infiltration, reduce runoff, reduce leaching, eliminate waste of water, encourage extensive root growth and maximize efficiency of plant water uptake. Use organic or organic-based fertilizers whenever possible (see Ref. 5below). • Test soil for nutrients, pH, heavy metals and other soil factors as appropriate, using a soil testing laboratory that provides testing appropriate for Massachusetts soils. Adjust soil pH and provide fertility according to soil test results. • Avoid pesticides that also kill beneficial organisms such as earthworms that aerate and fertilize the soil naturally. Choose proven biological pest management materials whenever possible.
Soil Moisture	Test soil for dryness. Water should soak down deeply enough to re-moisten the root zone, about 4-6 inches. This encourages deep root growth.

PLANTS	
Care and Maintenance Components	**Water Conservation Recommendations**
Plant Species	Choose plant species appropriate to the soil and sun exposure in the yard (see Ref. 1, 2, 5below).
Design & Layout	Group plants with similar watering requirements
Mulch	• Make sure smaller trees, shrubs and beds of plants are properly mulched; this saves water, keeps the weeds down and is good for the plants. • Use mulch to retain soil moisture and reduce the need for watering. The mulching material should allow for water infiltration into the soil/root zone. Be careful not to apply too much, because the soil does require some heat (see Ref. 7 below).

GRASS	
Care and Maintenance Components	**Water Conservation Recommendations**
Size of Grass Area	• Minimize lawn size and maintain/enhance existing native vegetation. Plant turf grass only where it has a practical function. • Understand that some areas may not grow turf, and watering a lot might not help. Where there are large trees, the combination of shading and the tree roots may make grass sparse.
Grass Species	Use drought-resistant/low-water-use grass species and cultivars. Fine fescues, including creeping red fescue, chewings fescue, and hard fescue, are drought tolerant and low maintenance in their needs, and are recommended low-water-use species. (see Ref. 5 below).
Grass Height	Mow lawns at the highest recommended height (at least 2.5 to 3 inches).
Pest Control	Practice Integrated Pest Management.[1, 2] Choose proven biological pest management materials to control grubs.whenever possible (see Ref. 3, 1, 5 below).
Fertilizing Grass	Follow Massachusetts regulations (330 CMR 31.00) on the use of plant nutrients (see Ref. 4 below). Application of phosphorus may not actually be necessary, based on the soil. Fertilizing for phosphorus and potassium should be done based on a soil test (and may not actually be necessary, based on the soil). through a laboratory that conducts tests appropriate for Massachusetts soils. Don't fertilize unless recommended by a soil test. Adjusting pH (usually by liming) should also be done basebased on a soil test. If fertilizer is needed, applications are best made in late summer-early fall and in mid-spring. Check weather forecasts before application and do not apply if heavy rain is forecasted. Organic fertilizer is (a light rain can substitute for recommended.[1, 2, 5] watering-in of a nutrient-containing material). Organic and organic-based fertilizers are recommended whenever possible. Where organic materials are the principal nutrient source being used over time, soil phosphorus levels should be monitored (see Ref. 4, 6 below).

SOILS

Care and Maintenance Components	**Water Conservation Recommendations**

~~Soil Health~~How much water?	• Massachusetts generally has enough rainfall (49 inches annually and 3 to 4 inches in July) to naturally supply the water needs of most healthy mature lawns with good soil, without the need for watering. • In years of drought and/or high heat, lawns may enter drought dormancy, turning brown and stopping growth. Turf should recover with the return of cooler weather and more moist conditions. When drought is severe and heat is extended for a long period of time, lawn managers should plan to overseed their lawns with desirable, drought tolerant grasses when cool, moist weather returns in late summer – early fall. Watering at overseeding and renovation is needed to establish healthy, weed-, pest- and drought-resistant lawns and fields. • Athletic fields and recreational areas that are used during drought dormancy will experience severe loss of turf, as the crowns of the grass plants will be unprotected by living foliage. It is best to keep traffic and play off drought dormant grass. If it is necessary to use such areas, especially if heat and drought are prolonged, the managers of those properties should plan to overseed or renovate the fields as necessary. Watering at overseeding and renovation is critical to successful establishment of healthy~~Ensure adequate depth and type of soil (at least 6 inches of good topsoil). Generally, a sandy loam with 5% organic content is recommended for turf grass and landscapes. The texture, organic content, pH level, drainage, salinity and fertility are important characteristics of soil that should be considered before planting anything.~~ ~~• Some tips for soil improvement include using peat moss, manure or compost to improve moisture retention, and using organic fertilizer for strong root growth. Peat moss must be thoroughly mixed with the soil in order to be effective at improving drainage characteristics. If used as a topdressing or over aeration holes, it can actually wick water away from the soil and roots. Choose manure and composts that are well decomposed. Manure and compost can be a source of weed seeds if not well decomposed.~~ ~~• Apply agricultural lime to neutralize acidic soils (if recommended by soil test results).~~ • ~~Avoid pesticides that also kill beneficial organisms such as earthworms that aerate and fertilize the soil naturally. Choose proven biological pest management materials to control grubs.~~ and weed-, pest-, and drought-resistant lawns and fields.
~~Soil Moisture~~	~~Test soil for dryness. Water should soak down deeply enough to recharge the root zone, about 4-6 inches. This encourages deep root growth.~~

~~PLANTS~~

~~Care and Maintenance Components~~	~~Water Conservation Recommendations~~
~~Plant Species~~	~~Choose plant species according to micro-climates in the yard.[2, 4]~~
~~Mulch~~	• During non-drought conditions, watering (**if necessary at all**) should be done to re-moisten the root zone (4-6 inches). The amount will depend on the soil and many other site factors. A general rule of thumb is one inch per week **including rain**, but some sites will need less and some may need more. ~~Use mulch to retain soil moisture and reduce the need for watering. Be careful not to apply too much, because the soil does require some heat.[3]~~

~~LAWN WATERING~~

~~Care and Maintenance Components~~	Water ~~Conservation Recommendations~~
~~How much water?~~	~~Massachusetts generally has enough rainfall to naturally supply the water needs of most healthy mature lawns with good soil, without the need for watering.~~ ~~• In years of drought and/or high heat, lawns may enter drought dormancy, turning brown and stopping growth. When drought is severe and heat is extended for a long period of time, lawn managers should plan to overseed their lawns with desirable, drought tolerant grasses when cool, moist weather returns~~

	in late summer – early fall. Watering at overseeding and renovation is critical to successful establishment of healthy, weed, pest and drought-resistant lawns and fields. Athletic fields and recreational areas that are used during drought dormancy will experience severe loss of turf, as the crowns of the grass plants will be unprotected by living foliage. It is best to keep traffic and play off drought dormant grass in order to avoid the development of unsafe playing surfaces and recreational areas. If it is necessary to use such areas, especially if heat and drought are prolonged, the managers of those properties should plan to overseed or renovate the fields as necessary. Watering at overseeding and renovation is critical to successful establishment of healthy, weed, pest and drought-resistant lawns and fields.
When to water?	Water between sunset and early morning. Avoid watering at night during hot humid weather to avoid disease outbreak, and avoid watering on windy days.
How to water?	Water slowly and deeply. Avoid pooling (runoff).
Rainwater	Collect rainwater for landscaping needs. Use rain barrels or larger containment systems and/or build a rain gar

AUTOMATIC IRRIGATION SYSTEMS

Care and Maintenance Components	Water Conservation Recommendations
Climate-based Controllers	Adjust your watering schedule to track weather conditions at least once or twice a month. Consider a SWAT (" Technology") compliant climate controller.[83]
Rain Shut-off	Install a rain shut-off device to prevent watering if it rains.
Maintenance	Inspect your system a few times during the watering season while it is running. Look for and repair leaking or reposition those that spray unintended areas. See Appendices J and K for additional information.
Testing	Hire an irrigation professional to test and adjust your system annually.
System settings	The best setting for irrigation systems is "off." Keep your system on manual and turn it on only when needed.[5]

REFERENCES

1) *A Homeowners Guide to Environmentally Sound Lawncare*, MA Department of Agricultural Resources, 1997
2) *More Than Just A Yard, Ecological Landscaping Tools for Massachusetts Homeowners*, Executive Office of Environmental Affairs, 2004
3) *Handbook of Water Use and Conservation*, Amy Vickers, 2001
4) *Garden and Landscaping Water Conservation Tips*, Massachusetts Water Resources Authority, 2005
5) *Greenscapes Guide*, Greenscapes Massachusetts, 2005

REFERENCES

1. Executive Office of Environmental Affairs. 2004. *More Than Just A Yard, Ecological Landscaping Tools for Massachusetts Homeowners*. (https://www.mass.gov/files/documents/2017/11/07/morethanjustyard.pdf)
2. Greenscapes Massachusetts. *Greenscapes Guide* (available for download at http://greenscapes.org/)
3. MA Department of Agricultural Resources, Integrated Pest Management (IPM) Six Step Approach. Available at http://www.mass.gov/eea/agencies/agr/pesticides/ipm-six-step-approach.html
4. MA Department of Agricultural Resources, Plant Nutrient Management. Available at https://www.mass.gov/plant-nutrient-management
5. University of Massachusetts Extension Turf Program. 2013. Best Management Practices for Lawn and Landscape Turf. Ver. 1.51. (http://ag.umass.edu/turf/publications-resources/best-management-practices)

[83] See EPA WaterSense specification for landscape irrigation controllers at www.epa.gov/watersense/products/controltech.html.

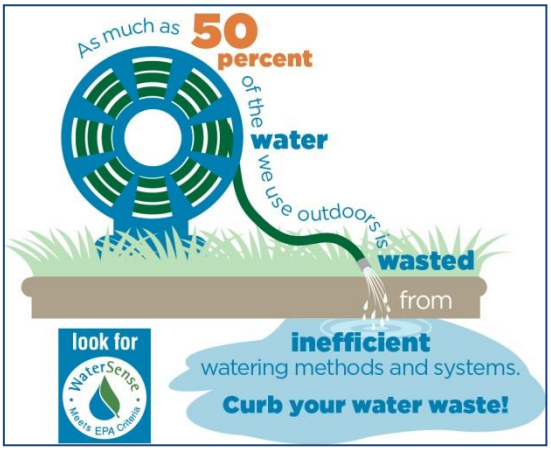
6. University of Massachusetts Extension Turf Program. Nutrient Best Management Practices. Available at https://ag.umass.edu/turf/publications-resources/nutrient-management-information
7. Vickers, Amy. 2001. *Handbook of Water Use and Conservation.* Amherst, MA: WaterPlow Press.

I) Guidelines for Efficient Irrigation

Common-Sense Guidelines for Watering Landscapes

For hand watering, manual sprinklers, or more complex irrigation systems, observe these five common-sense principles:

1. Water only when needed. Rainfall in Massachusetts generally provides enough water for landscape needs.
2. Water early in the day. Do not water between 9:00 AM and 5:00 PM.
3. Water deeply and less often to encourage deep root growth.
4. Know the water needs of each part of your landscape and water accordingly.
5. Direct water to vegetated areas; avoid spraying sidewalks, driveways, decks, and other hard surfaces.



Automatic Irrigation Systems

Consult WaterSense or Irrigation Association guidelines (see References below) for irrigation system design, installation, operation, auditing, and maintenance. Irrigation systems should:

- Be designed or installed and audited by an irrigation professional certified by a WaterSense labeled program
- Be designed and installed to sustain the landscape without creating runoff or direct overspray
- Achieve at least a 65 percent distribution uniformity
- Be equipped with technology that inhibits or interrupts operation during periods of rainfall or sufficient moisture, **as required by Massachusetts law** (MGL ch.21 §67); this includes Smart Water Application Technology (SWAT), such as WaterSense-labeled irrigation controllers meeting specified criteria
- Use fixed-spray irrigation on turfgrass only; use drip or micro-irrigation on all plants other than turfgrass

Guidelines for Irrigation System Audits

WaterSense guidelines for irrigation audits are reproduced in Attachment I-1 to this appendix. The Irrigation Association also provides audit guidelines and worksheets at http://www.irrigation.org/IA/Resources/Technical-Resources/Irrigation-Auditing/Audit-Guidelines/IA/Resources/Audit-Guidelines.aspx.

References

Irrigation System BMPs:

- EPA WaterSense. July 24, 2014. Section 4.2, "Irrigation System," in WaterSense New Home Specification (available at https://www.epa.gov/watersense/homes-specification)
- Irrigation Association. May 2014. Landscape Irrigation Best Management Practices (available for download on this page: https://www.irrigation.org/IA/Advocacy/Standards-Best-Practices/Landscape-Irrigation-BMPs/IA/Advocacy/Landscape-Irrigation-BMPs.aspx?hkey=93b546ad-c87a-41b8-bf70-8c4fd2cff931)
- University of Massachusetts Extension Turf Program. 2016. Best Management Practices for Lawn and Landscape Turf. Ver. 1.51. Section 6, "Irrigation and Water Management" (available at http://ag.umass.edu/turf/publications-resources/best-management-practices)

Irrigation Controllers, best available technology:

- EPA WaterSense. Specification for Weather-Based Irrigation Controllers. Ver. 1.0, November 3, 2011 (or as updated) (available on the Specifications tab at https://www.epa.gov/watersense/irrigation-controllers)

Alternative sources of water:

- EPA WaterSense. October 2012. Section 8, Onsite Alternative Water Sources, in WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities (available at https://www.epa.gov/watersense/best-management-practices; scroll down to "Alternative Water Sources" link)

Attachment I-1. Guidelines for Irrigation Audits

Source: https://www.epa.gov/sites/production/files/2017-01/documents/ws-homes-irr-audit-guidelines.pdf

Audit checklist at: https://www.epa.gov/sites/production/files/2017-01/documents/ws-homes-irr-audit-checklist.pdf

Guidelines for Irrigation Audits on WaterSense® Labeled New Homes

After the irrigation system is installed, an irrigation professional certified by a WaterSense labeled program must conduct an audit of the system. EPA prefers that the auditor be independent of the professional who designed and installed the system. If this is not the case, please indicate on the *WaterSense Labeled New Home Irrigation Audit Checklist* what the certified irrigation professional's role was during design and installation. EPA recommends that the certified irrigation professional conduct the audit according to the Irrigation Association's Certified Landscape Irrigation Auditor Training Manual (2004). The audit shall include, but is not limited to, the following components:

A. Distribution Uniformity Calculation (Section 4.2.5)

The *WaterSense New Home Specification* requires that irrigation systems achieve a lower quarter distribution uniformity (DU_{LQ}) of 65 percent or greater and that distribution uniformity be measured on the largest spray-irrigated area during the post-installation audit.

- Determine the DU_{LQ} of the system using the catch-can method. This test shall be conducted according to the Irrigation Association's *Recommended Audit Guidelines* located at www.irrigation.org/Resources/Audit_Guidelines.aspx. The test shall include areas of turfgrass only and shall be conducted on the largest spray-irrigated area. Verify that the $DU_{LQ} \geq 65\%$.

B. Irrigation System Design (Sections 4.2.3 through 4.2.10)

Conduct a visual inspection to verify the following specification criteria are met. The results of the visual inspection shall be recorded by the certified irrigation professional on the irrigation audit checklist.

- The irrigation system operates without leaks (Criterion 4.2.3).
- There is no runoff or overspray from the irrigation system that leaves the property during a minimum operating duration determined to be appropriate for the system by the certified irrigation professional (Criterion 4.2.4).
- The irrigation system includes a technology that inhibits or interrupts operation of the irrigation system during periods of rainfall or sufficient moisture (e.g., rain sensors, soil moisture sensors) (Criterion 4.2.6).
- The irrigation system is equipped with a WaterSense labeled weather-based irrigation controller or a soil moisture senor-based irrigation controller that contains the following capabilities in both smart and standard mode (Criterion 4.2.7):
  1. Preserves the contents of the irrigation program settings when the power source is lost without relying on external battery backup.
  2. Has independent, zone-specific programming or the ability to store a minimum of three different programs to allow for separate schedules for zones with different water needs.
  3. Indicates to the user when it is not receiving a signal or local sensor input and is not adjusting irrigation based on current weather or soil moisture conditions.
  4. Interfaces with a rainfall device.

5. Accommodates watering restrictions as follows:
   - Operation on a prescribed day(s)-of-week schedule (e.g., Monday-Wednesday-Friday, Tuesday-Thursday-Saturday; any two days; any single day).
   - Either even-day or odd-day scheduling, or any day interval scheduling between two and seven days.
   - The ability to set irrigation runtimes to avoid watering during a prohibited time of day (e.g., between 9:00 a.m. and 9:00 p.m.).
   - Complete shut-off (e.g., on/off switch) to accommodate outdoor irrigation prohibition restrictions.
6. Includes a percent adjust (water budget) feature. The percent adjust (water budget) feature is defined as having the means to increase or decrease the runtimes or application rates for zones by means of one adjustment without modifying the settings for each individual zone.
7. Reverts to either a proxy of historical weather data or a percent adjust (water budget) feature if the primary source of weather or soil moisture information is lost.
8. Allows for a manual operation troubleshooting test cycle and automatic return to smart mode within some period of time as designated by the manufacturer, even if the switch is still positioned for manual operation.

- Sprinkler heads, other than as part of a micro-irrigation system, have a 4-inch or greater pop-up height and matched precipitation nozzles (Criterion 4.2.8).
- Sprinkler irrigation, other than as part of a micro-irrigation system, is not used to water plantings other than maintained turfgrass (Criterion 4.2.8).
- Sprinkler irrigation, other than as part of a micro-irrigation system, is not used on turfgrass strips less than 4 feet wide nor on slopes in excess of 4 feet of horizontal run per 1 foot vertical rise (4:1) (Criterion 4.2.8).
- Micro-irrigation systems include, at a minimum: pressure regulators, filters, and flush end assemblies (Criterion 4.2.9).
- Two schedules have been created and are posted by the irrigation controller (Criterion 4.2.10):

  1. A schedule for the initial grow-in phase
  2. A schedule for the established landscape

  Irrigation schedules shall vary according to the seasons, reflecting the varying irrigation needs throughout the year. In addition, schedules shall comply with local water restrictions.

C. Verification of Operating Pressure

Verify that the station or zone pressure based upon emission device or product being used (spray head, rotor head, drip emitter) is within +/- 10 percent of manufacturer-recommended operating pressure. Test this on a representative zone of each irrigation type (e.g., spray, rotor, drip, etc.).

J) Checklist for lawn and landscaping irrigation water efficiency

Consider the following to increase the beauty, health and efficiency of your landscape.

Look into Automatic Irrigation System Programming:

Normally, lawns need no more than one inch of water per week throughout the summer, and this includes precipitation, ***so often there is no need to water at all***. Make sure your irrigation system does not deliver more water than one inch per week, including precipitation. If there are problems with the lawn turning brown or looking dry, it is likely that there are other problems or issues, and solutions other than increasing irrigation.

Evaluate the programming of the sprinkler system:

1. Make sure the system delivers no more than one inch of water per week (test the system if necessary – see some options below for testing automatic irrigation systems).
2. Make sure that the irrigation system delivers a reasonable amount of water to each zone, delivering water as each zone needs: less to shaded areas, while trees and well-established shrubs will probably not need any irrigation.
3. Adjust the system seasonally: if you must water in the spring and fall, reduce the system run time during these more moderate seasons.
4. Adjust the system according to weather: if it has been more cool and cloudy than usual, over-ride the system temporarily to save water.
5. Make sure the system operates at night (except on very hot humid nights) or in the early morning (before 8:00 am), not during the day.
6. Watering longer twice per week instead of short times every day can help plants and turf grow longer roots and stay healthy with less irrigation. Adjust your sprinkler system for less frequent watering.
7. Know the watering restrictions of your community and follow them. Make sure your irrigation system is programmed to water only during times allowed, and make sure it is compliant in other respects (some communities require an irrigation system be registered, have a working rain sensor (as mentioned below), and / or other requirements).

Tests for the sprinkler system:

Test for the amount of water – I

- Place measuring cups down on the lawn in each sprinkler zone (these will need to be calibrated like rain gauges, to show the inches of precipitation the ground has received)
- Run the sprinkler system through a test cycle.
- Note the run time of each sprinkler zone during the test cycle.
- Using the amount of water delivered to the lawn during the test cycle and the schedule of the sprinkler system, determine the amount of water that goes on to the lawn each week.
- The amount of water should be no more than one inch per week.

Test for the amount of water – II

Not only can the following procedure be used to get an idea if the irrigation system is using more water than needed, it can also be used to determine whether more water is being used because of worn sprinkler heads, which is a common problem as sprinkler systems age.

- Plan the test for a time when no water will be used or needed anywhere else in the house or on the premises
- Read the water meter
- Be ready to time the sprinkler system test cycle
- Run the sprinklers through a test cycle while no other water is being used, timing the cycle
- Read the water meter

- Calculate the water used during the test cycle from the readings before and after, and the meter constant
- Calculate the average water use per minute (flow rate) by the sprinkler system in gallons per minute (GPM)
- Compare the water flow rate with what should normally be used by the sprinkler heads in each zone (this would be the sum of the rated flows for each sprinkler head). If the flow rate is significantly greater than what manufacturer's data might indicate, sprinkler heads may be worn.
- Using the amount of water delivered to the lawn during the test cycle, the schedule of the sprinkler system, and the area of the lawn, determine the amount of water that goes on to the lawn each week.
- The amount of water should be no more than one inch per week (remember that this one inch includes precipitation).

For sprinkler system uniformity
See Appendix K.

Automatic Irrigation System Performance:
Sprinkler system spray and distribution
Try to determine if the sprinkler heads are worn, and hence using more water than they were designed for. Other signs of problems include:

- broken heads
- areas being over-watered
- pavement or any non-lawn areas being watered
- the same schedule for a north-facing area as for a south-facing area
- signs of piping leaks
- water run-off (if so, soil aeration may be needed)
- uneven spray patterns

Use properly installed soaker hoses instead of sprinklers for beds of plants to reduce evaporative losses (if these beds must be watered, see notes on this below). Make sure your sprinkler system has a working rain sensor, set at ¼ of an inch of precipitation, and properly located (not under an overhang or any place where it is sheltered from the rain).

Water pressure
Check the system pressure. If the street water pressure is above the rated pressure for the irrigation system, that system will need a working pressure reducer valve to bring that pressure down to the correct level, or damage to the irrigation system can occur and water will be wasted.

Irrigation needs for plants and shrubs
Look to see if there are well-established shrubs or trees that are being watered by the irrigation system, and consider capping off sprinkler heads that water them. The plants might have needed watering at one time, but may not anymore. Many irrigation systems provide far more water to plants and shrubs than needed. Often, a new landscape in New England features plants that need plenty of water until established, and then they do not need any irrigation – the natural rainfall is quite enough.

Soil / Plant Health
Check for soil and plant condition by the following:

- Perform a few soil core samples (with a trowel if you do not have a core sampler), looking at depth and type of topsoil, root depth, etc. Lawns should have at least six inches of good topsoil.
- It is possible to perform a simple soil test to indicate proportions sand, silt, loam and clay.
- Examine the condition and types of plants and turf.

- Check for soil pH (degree of acidity): acidic soil can greatly decrease the health of a lawn, and can affect plants that do not like these conditions. Depending on a soil test, neutralize acid with limestone; this may need to be done every year or every few years. (Note: acid rain does not cause acidic soil.)
- Understand that some areas may not grow turf, and watering a lot might not help. Where there are large trees, the combination of shading and the tree roots may make grass sparse.
- Make sure smaller trees, shrubs and beds of plants are properly mulched; this saves water, keeps the weeds down and is good for the plants.
- Look for areas where soil may be compacted.

Consider the following actions:

- Aeration of soil
- Adding lime
- Top dressing the turf with compost to improve soil
- Using an organic fertilizer instead of chemical fertilizers
- The most important time to fertilize is in the late summer–early fall (late August – September)
- Improvements to sprinkler system operation and design
- Installation, relocation, and/or re-setting of a rain sensor
- Landscape creatively with larger plants, beds of mulched plants, and many other options
- Consider lettering an area "go wild" for a while, and allow whatever plants to grow naturally without any action on your part (in New England, this is likely to get you a wildflower garden during the summer). Be aware that this can potentially increase the dog and deer tick populations in a yard.

If you are looking for a home:

Check the amount of topsoil

Insist on checking the level and quality of the soil under the lawn, and let the person showing you the home know that this is important to you.

Unfortunately, much of the newest construction is also the most inefficient when it comes to irrigation system efficiency. New construction in recent years has often involved bulldozing nearly everything, removing topsoil and most of the subsoil, grading the landscape, adding just a few inches of loam. The homeowner is then left with trying to keep grass green using an automatic sprinkler system rather than natural conditions.

At least 6 inches of topsoil is recommended. Generally, a sandy loam with 5% organic content is recommended for turf grass and landscapes. Some tips for soil improvement include using peat moss, manure or compost to improve moisture retention, and using organic fertilizer for strong root growth.

This list was developed with assistance from Russ McIntosh of Sebesta Blomberg & Associates, Inc.
The above guidelines are intended to be a general set of good practices for conserving water used for irrigation in residential and commercial settings. They do not necessarily cover all situations.

These guidelines were prepared mostly with technical information from research and development of the landscaping water audit offered as a service by Energy New England, LLC. Help was provided from the Water Departments of the Towns of Acton and Concord, Massachusetts.

J) Massachusetts Drought Management Outdoor Water Use Restriction Guidelines

The actions below are statewide guidance under conditions of regional drought and represent one of the most important steps that can be taken to minimize the impacts of drought on water supply and the environment.

State Drought Condition	Nonessential Outdoor Water Use Restrictions
Level 1 (Advisory)	1 day per week watering, and only after 5 p.m. or before 9 a.m. (to avoid evaporative losses)
Level 2 (Watch)	Outdoor watering should be limited to hand-held hoses or watering cans, to be used only after 5 p.m. or before 9 a.m.[84]
Level 3 (Warning)	Ban on all nonessential[85] outdoor water use
Level 4 (Emergency)	Ban on all nonessential[64] outdoor water use

[84] Watering of municipal parks and recreation field with irrigation systems and sprinklers may continue, at the water supplier's discretion, after 5 p.m. and before 9 a.m.

[85] Essential uses are defined by MassDEP as uses required: a) for health or safety reasons; b) by regulation; c) for the production of food and fiber; d) for the maintenance of livestock; or e) to meet the core functions of a business. Nonessential uses are those *other than* essential uses.

K) Turf and Landscape Irrigation Best Management Practices

Landscape irrigation is a process to supplement precipitation by artificial means, with the goal of maintaining soil moisture during the growing seasons of turf and ornamental plants. It is vital that a set of standards is formed that incorporate best management and conservation practices to protect Massachusetts' water resources from misuse. Conservation measures are any water management practices and water efficiency measures resulting in beneficial reduction in water loss, waste, or use.

Introduction

This appendix presents Best Management Practices (BMPs) for irrigation of turf and landscapes. These BMPs support the design, installation, maintenance, and management of landscape irrigation systems in ways that save water and protect water quality.

1. Water Quantity – using water as efficiently as possible while providing for the needs of the plants. Many landscape plants require supplemental irrigation to meet their intended aesthetic or recreational function. Supplemental irrigation should equal the evapotranspiration rate of the plant being maintained minus any precipitation that occurred. Excessive irrigation is not only wasteful but can have a negative impact on plant health and water quality.
2. Water Quality – irrigation at a rate equal to or less than the infiltration rate of the soil. This prevents surface runoff and limits the off-site movement of sediment, pesticides, and nutrients. Irrigation that exceeds the water holding capacity of the soil may lead to leaching of pesticides and nutrients. Maintaining a healthy plant cover increases soil infiltration rates and minimizes soil erosion and sedimentation of surface waters. This mitigates the effects of storm events and flooding.
3. Soil Conservation – improving the physical, biological, and chemical properties of the soil. A healthy plant cover provides for improved infiltration of rain or storm water and reduced erosion. A robust plant/soil system filters contaminants and ensures a healthy aquifer recharge.
4. Plant Management – employing sound agronomic/horticultural practices, including irrigation, to maximize plant health and performance.

The goal is to provide landscape irrigation owners and operators with tools to understand, implement, and manage efficient turf and landscape irrigation systems.

► BMP 1 Design the Irrigation System for the Efficient and Uniform Distribution of Water

The irrigation system shall be designed to be efficient and to uniformly distribute water. Specific criteria that shall be considered in the design include soil type, slope, root depth, plant materials, micro-climates, weather conditions and water source (e.g., quantity, quality and pressure). To conserve and protect water resources, the irrigation designer shall select appropriate equipment components that meet state and local code requirements and site requirements. Specific design considerations should include:

- The design should be based on a thorough evaluation of physical, environmental, and hydrogeologic site conditions.
- Placement and spacing of sprinklers should be based on performance data and site-specific considerations.
- The use of pressure-regulating devices in the system will maintain water distribution uniformity throughout the zone.
- All plants within a sprinkler zone should have similar water requirements and root depths. Plants with different water requirements (such as grass and shrubs) should be in separate zones.
- Watering cycles should be scheduled for times of low wind and low evaporation.
- Sprinkler heads must be spaced to provide head to head coverage, using guidelines suggested by the manufacturer, and wind factors must be considered.
- Sprays and rotor irrigation heads cannot be used within the same zone.
- Sprinklers located on a steep slope require check valves be installed on all heads on that irrigation zone.
- The irrigation design should consider the different micro-climates found in most landscapes.
- The controller should have multiple programs so these different irrigation schedules can be utilized.

- "Smart" controllers should be considered for operation of the system.[86]
- Guidelines on pressure at the head/emitter,
  - Spray Heads - 20 to 35 pounds per square inch (psi)
  - Gear Rotors - 60 psi or less
  - Impact Rotors - 60 psi or less
  - Drip emitters - 40 psi or less
- Do not allow water to spray onto non-landscaped areas.

► BMP 2 Install the Irrigation System to Meet the Design Criteria

Irrigation systems shall be installed according to design specifications, manufacturer's specifications, and state and local code requirements. The installation should result in an efficient and uniform distribution of water. The irrigation contractor or installer shall be licensed and/or certified where applicable.

- The installed irrigation system shall have a rain interruption device.
- The installer will ensure qualified supervision of the installation process.
- Final inspection and approval of the system shall be conducted by a qualified and authorized individual.
- Review as-built design, operation manual, and system orientation with owner/manager.
- A set of actual construction drawings, updated daily by the installing contractor and clearly annotated shall be kept during the construction process. The final as-built document should include the locations and sizes of the water meter, shutoff valves, backflow prevention device, mainline pipes, zone valves, lateral pipes, sprinklers, controller locations and sensors.
- A written manual of suggested maintenance of the system, including winterizing and start-up procedures, shall be submitted to the owner.

► BMP 3 Maintain the Irrigation System for Optimum Performance

The irrigation system shall be regularly serviced to maintain the performance of the system as designed. Maintenance shall result in sustaining an efficient and uniform distribution of water.

- Appropriate personnel shall educate and train the system manager on proper use, operation, and capacity of the system. This includes seasonal adjustments or system shut-down based on prevailing or impending weather conditions.
- The irrigation schedule should be routinely modified based on plant health and vigor and should account for current and anticipated weather, pest pressure, or other pertinent conditions.
- In order to prevent runoff, the irrigation schedule should not exceed the soil infiltration rate.
- Periodically perform a thorough inspection of the system to verify that all components meet the criteria for efficient operation and uniform distribution of water, and repair or replace components as needed. Perform periodic visual inspections while the system is operating to check for needed repairs and adjustments.
- Qualified persons should perform start-up of the system in spring and shut-down in winter.

[86] "Smart" controllers are controllers that use water more efficiently than traditional timers by monitoring specific site conditions – including plant and soil type, slope, soil moisture, and weather conditions – and by automatically adjusting the watering schedule on an ongoing basis to provide the right amount of water for each part of the landscape each day. They turn sprinklers on and off in response to actual environmental conditions such as, soil moisture, rain, wind, slope, soil, plant type, etc., and thus provide only the amount of water needed. Source: Irrigation Consulting, Inc.

► ***BMP 4 Incorporate Other Techniques that Result in Water Conservation***

Landscape irrigation will be most effective when implementing a variety of techniques that result in water conservation. These techniques may include:

- water audits
- alternative plant species (drought tolerant plants)
- reclaimed water and/or retained storm water
- deficit irrigation scheduling
- soil cultivation/aeration
- syringing[87]
- soil amendments and wetting agents
- soil and nutrient management
- mulches

These Best Management Practices were developed with assistance from the Irrigation Association of New England, P.O. Box 354 Concord, NH 03302
Tel: (603) 679-9991; www.irrigationassociationne.org

[87] Syringing is a quick spray technique, used only on occasion to provide instant cooling of the grass. It is used mainly in athletic fields and golf courses.

L) Local Water Conservation Efforts

This appendix includes successful water conservation efforts in many Massachusetts communities that could serve as examples in other cities and towns. Features of their water conservation programs are highlighted below. Please note that this is not an endorsement of the WRC.

Acton[88]

The Acton water district provides water to the town from eleven wells located within the town. The district's system consists of 106 miles of water main, four storage tanks, and a variety of treatment facilities that assist in the production of high quality finished water. The district is faced with demand during peak use seasons as Acton's population increases. The town's water withdrawal permit allows for an average withdrawal of 1.92 mgd. On peak demand days (generally during the months of May-October) water use can reach and exceed 2.45 mgd. Although use is lower during the winter months, the annual average withdrawals come very close to the limit.

CONSERVATION EFFORTS

Conservation measures, such as limitations on outdoor water use and water efficient landscape designs and practices have been shown to result in average water savings of up to fifty percent. Such savings would allow Acton to sustain itself for the foreseeable future on existing supplies.

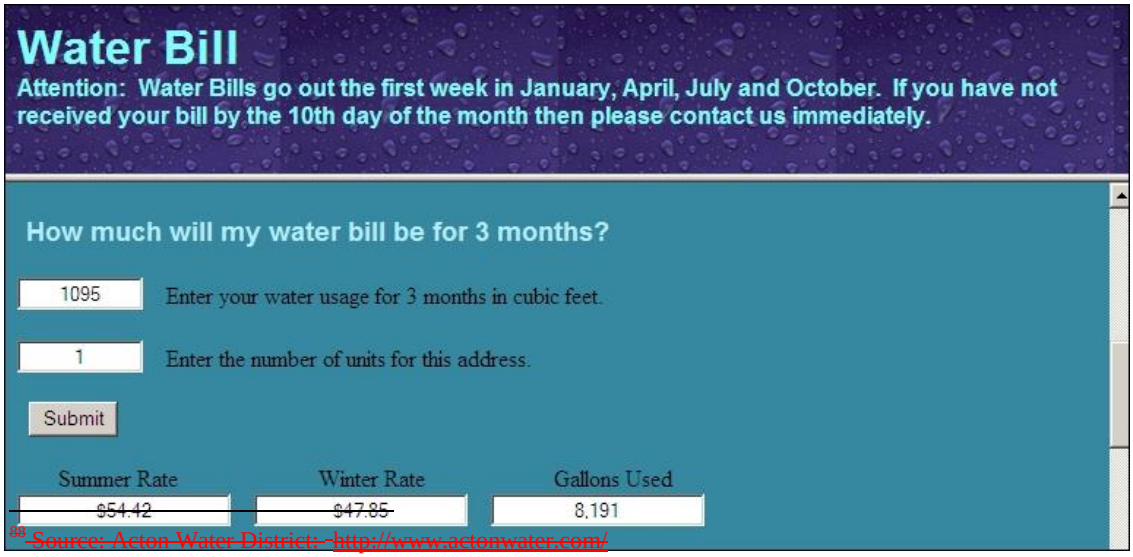
1. Pricing

The water rates are based upon consumption; inclining block rates have been set to encourage conservation.

Inclining Block Rates in cubic feet	January Bill Winter Rate	April Bill Winter Rate	July Bill Summer Rate	October Bill Summer Rate
Service Charge per Unit	$15.00	$15.00	$15.00	$15.00
Between 0 and 2000	0.03	0.03	0.036	0.036
Between 2001 and 4000	0.033	0.033	0.042	0.042
Between 4001 and 6,000	0.045	0.045	0.053	0.053
Greater than 6,000	0.054	0.054	0.063	0.063
Municipal Rate	0.032	0.032	0.032	0.032

Rates, other than per unit charge, are per cubic foot, as of July 1, 2010. cf = cubic feet; 100 cf = 748 gallons.

Online water bill calculator in the "Water Bill" section at http://www.actonwater.com/.



[88] Source: Acton Water District: http://www.actonwater.com/

2. Outdoor Watering

Every year from May 1st to October 1st, strict outdoor water restrictions are put into effect – no lawn can be watered from **7AM-7PM**. The town of Acton has also formulated a weekly rotation system in which certain people will be able to use water outdoors on specific days of the week. **Even** numbered houses may use water outdoors on **Tuesday, Thursday,** and **Saturday**. **Odd** numbered houses may use water outdoors on **Wednesday, Friday,** and **Sunday.** No household is allowed to use water outdoors on Monday.

3. Outreach and Education

The philosophy of Acton's water conservation program is that the school children of today will soon be tomorrow's water resource stewards. Teaching children to value and protect their drinking water is an important investment in the future, as well as an excellent way to send a message home to parents. The Acton Water District's education program is offered free of charge to all students and teachers in Acton's Public Schools.

The following are provided to schools:

- Classroom visits and field trips with Water District staff;
- A menu of drinking water-related lessons and activities that can be presented by Water District staff, or provided to teachers for their own implementation;
- Lesson plans that incorporate the Massachusetts Department of Education Science and Technology Curriculum Frameworks;
- Consultation on integrating drinking water topics into science curriculum;
- Lending library of educational videos, books, and other resources;
- Special activities each spring during Drinking Water Week; and
- Sponsorship of student summer internships and special drinking water-related projects.

~~*Concord*~~[89]

~~With a total population of 17,600 people, the town of Concord supplies 97% of its water. Average daily residential demand is 68 gallons per person and overall demand fluctuates between 2 mgd in the winter and 5 mgd in the summer. Satisfying demand during the peak summer months is particularly challenging. The town is supplied by a total of six groundwater wells and one surface water withdrawal (summer use only). The water is 100% metered and is distributed among: residential (65%); industrial, commercial and institutional (33%); municipal (1%); and second meter (1%) users.~~

~~CONSERVATION EFFORTS~~

~~1. Metering and Leak Detection~~

~~All customers in Concord are metered. The metering program also includes free maintenance. This ongoing maintenance helps the town quickly detect any leaks or problems with the system. Technologies such as radio meters, weather-based irrigation controllers, and waterless urinals have played a key role in the water conservation efforts. The town conducts free residential water audits for its large users. Concord has also given incentives to switch old toilets and washing machines for new, more efficient ones. It also provides free leak detection kits, flip aerators, low-flow showerheads, shower timers, and rain gages.~~

~~2. Pricing~~

~~Concord employs full-cost pricing and has an enterprise account for water. The town has seasonal conservation water rates (rates as of June 1, 2011).~~

~~*Residential Water Users – Single Unit Residential*~~

~~Base Rate: $4.10per 100 cf bimonthly and year round.~~
~~Step 2: $8.20 per cf for 2,500 – 4,800 cf bimonthly May 1 through October 31.~~
~~Step 3: $10.25 per cf over 4,800 cf bimonthly May 1 through October 31~~

~~Approximately 2/3 of the residential customers stay within the 1st step (block pricing). Besides residential users, small businesses also stay within this first step. Year-round, the following rates apply:~~

~~*Industrial, Commercial and Institutional Water Users (General Service)*~~

~~1st step < 5000 cf = $4.10/cf~~
~~2nd step > 5000 cf = $5.21/cf~~

~~*Municipal Water Users*~~

~~$4.04/ccf~~

~~3. Outdoor Watering~~

~~In the town of Concord, irrigation represents a significant problem. Households with irrigation systems are consuming 75% more water on average, due to the watering and over-watering of lawns. In 2005, 27% of the total water withdrawn was used by 10% of the residential users. All irrigation systems are required to be registered with the town. The irrigation systems also need to include specific components – rain sensors, programmable devices, and reduced-pressure backflow devices. While about 380 of these systems have been registered, approximately 400 are thought to be unregistered.~~

~~4. Outreach & Education~~

~~The town of Concord does extensive education and outreach. These include the *Water Connection* newsletter that is available to customers twice a year, a rain barrel program, lawn signs, inclusion of conservation in the 4th grade curriculum, demonstrations on how to maintain a garden without wasting water excessively, and templates on how to create water-smart landscapes. Through these programs, the town of Concord hopes to spread the efforts and benefits of Water Conservation.~~

---

[89] ~~Source: www.concordma.gov/Pages/ConcordMA_water/water%20efficiency and MAPC, "Summer Smart Water Use- A Guide to Peak Season Water – Demand Management." Metropolitan Area Planning Council and 495/MetroWest Corridor Partnership, May 2006. Available at http://www.mapc.org/resources/watersmart-toolkit.~~

~~*Dedham-Westwood*~~[90]

~~The Dedham-Westwood Water District is responsible for distributing water to approximately 38,000 people. On an average day, the District pumps about 4.25 million gallons of water from eleven artesian wells, six in Westwood and five in Dedham. In December of 2005, the District was granted membership into the Massachusetts Water Resources Authority, allowing it to purchase supplemental water, when needed, to ensure public health and safety during peak water-use periods.~~

~~CONSERVATION EFFORTS~~

~~The Dedham-Westwood Water District has established a very strong and organized water conservation program. This program is divided into four stages. The first stage covers voluntary conservation, i.e. people responding to simple public requests or suggestions. The second stage describes a list of penalties that a person will receive if caught breaking the rules. At the third stage, the whole town goes under a mandatory restriction, and is given a schedule of when outdoor watering is permitted. The fourth stage is a re-enforcement of the third. Municipal crews drive around the city, and if they see a violation, they issue a warning. If the person is seen violating for a second time, a second warning is issued with a fine.~~

~~1. Metering~~

~~Electronic Meter Program – Most commercial water accounts have been outfitted with new radio-read meters. All new residential meters, both new construction and meter change-outs at existing properties, also use this technology. Water bills will be issued monthly once the entire system is equipped with radio meters.~~

~~2. Pricing~~

~~Residential customers are billed quarterly while large commercial and industrial customers are billed monthly. The Water District has an inclining block rate. For residential water users,~~[91] ~~the fixed fee is $11.84 for every 100 cubic feet or 748 gallons of water. Residential rates are per quarter. Each resident is allowed 300 cubic feet at his rate. There are three inclining blocks above the minimum charge; the rate for the largest water users is $8.77 per hundred cubic feet for consumption greater than 75 hundred cubic feet (56,000 gallons).~~

~~3. Residential Rebates~~

~~The District offers a $50 rebate for low-flow toilets, $75 for high-efficiency toilets, and $100 for front-loading washing machines (http://www.dwwd.org/conservation-rebate-program).~~

~~4. Outdoor Watering~~

~~The Dedham-Westwood Water District offers detailed guidelines for water-use restrictions at three increasingly severe stages of a water supply emergency.~~

~~*Stage I-A: Voluntary odd / even outside water use policy*~~

- ~~Public requested to conserve water and refrain from watering lawns.~~
- ~~Publicity that mentions the need for water conservation, and suggests possible methods to conserve.~~

~~*Stage I-B: Mandatory odd / even outside water use policy*~~

- ~~Public is required to restrict lawn watering to every other day based on address and calendar date.~~
- ~~The District Water Commissioners may invoke monetary or other penalties for customers who violate any mandatory restriction order such as:~~
  - ~~First Violation: Warning~~
  - ~~Second Violation: $100.00 fine~~
  - ~~Third and Additional Violations: $250.00 and discontinuance of water service. A reactivation fee of $250.00 will be charged before water service is restored.~~

~~*Stage I-C: Mandatory restrictions on lawn watering by Town to two days per week between the hours of 6 a.m. to 9 a.m. and 6 p.m. to 9 p.m.*~~

---

[90] ~~Source: http://www.dwwd.org/~~

[91] ~~Rates effective as of January 25, 2011.~~

Lawn watering is permitted only on Monday and Thursday in Dedham, and on Tuesday and Friday in Westwood. No lawn watering is allowed on Wednesdays, Saturdays, and Sundays. Hand-held hoses may be used for flower and vegetable gardens without hour and day restrictions.

Stage 1-D: Mandatory restrictions on lawn watering to one day per week between the hours of 6 a.m. to 9 a.m. and 6 p.m. to 9 p.m.

- The public is required to restrict lawn watering as noted below and requested to conserve water in all other practicable ways.
- Hand-held hoses may be used for watering flower and vegetable gardens and shrubbery without day or hour restrictions.
- Pools less than 10,000 gallons may be filled until Memorial Day only.

Allowed Day	**Town**	**Address**
Monday	Dedham	Odd
Tuesday	Westwood	Odd
Thursday	Dedham	Even
Friday	Westwood	Even

Lawn watering is **not** permitted on **Wednesdays, Saturdays, or Sundays.**

Stage II-A: Purpose is to reduce water consumption with minimum hardship or economic loss to individuals and business concerns

Use of the affected public water supply for any of the following purposes is prohibited:

- Watering shrubbery, trees, lawns, grass, plants.
- Washing vehicles or other mobile equipment
- Washing streets, driveways, parking lots, etc.
- Operation of any ornamental fountain or something similar.
- Filling (from an empty or less than three-quarters full condition) of swimming pools
- Service of drinking water in restaurants, except on request.

Stage II-B: In addition to those measures included in Stage II-A, use of affected public water supply for any of the following purposes is prohibited

- Adding water to any kind of outdoor swimming and/or wading pools, or to fountains, reflecting ponds, or other ornamental structures.
- Any other use of water supply for outdoor recreation.
- Air conditioning, where interior temperature is less than 78 degrees Fahrenheit.

Stage II-C: In addition to those measures included in Stages II-A and B, the use of affected public water supply for any of the following purposes is prohibited

- Adding water to indoor swimming pools.
- School athletic programs and other indoor athletic/recreation activities, including health spas.
- Fire hydrants other than for health and safety purposes.
- Construction purposes, including hydro-seeding, dust control, and filling or flushing water mains for new development.
- Commercial vehicle and automotive equipment washing.
- Watering of golf course greens.

Stage II-D: In addition to those measures included in Stages II-A, B and C, use of affected public water supply for any of the following purposes is prohibited

- Make-up water for air conditioners.
- Watering of plants by commercial nurseries and agricultural water users.
- Use of automatic ice making machines in hotels and motels.
- Production of bottling of beverages.
- Operation of any commercial or industrial facility which is ordered closed by the local jurisdiction.

Stage III: In addition to those measures included in Stages II, the use of water for any purpose not essential to life, health and safety is prohibited.

Ipswich[92]

The town of Ipswich is 33 square miles in area and home to approximately 13,175 people. Seventy percent of Ipswich's area is served by a single public water supplier, the Water Division of the Utilities Department. The Ipswich Water Division obtains water from six groundwater sources and two surface water sources, in both the Parker and the Ipswich river watersheds. The population projected for the town under build-out conditions is 23,089. In 2000, Ipswich received a consent order for exceeding its registered withdrawal limits. A water conservation plan with features outlined below was developed to fulfill requirements associated with Ipswich's WMA permit application.

CONSERVATION EFFORTS

1. Metering and Leak Detection

The town of Ipswich has completed installation of automatic meters throughout the town. Over the last few years, the Ipswich Water Division has had a widespread program to prevent leaks. Leak detection takes place annually in all households and businesses of Ipswich. The Water Division offers residential water audits free-of-charge to customers who suspect they are wasting water. Commercial water use does not fluctuate seasonally like residential water use. If a commercial customer does show a significant unexplained increase in consumption, the Water Division works closely with the customer to determine the cause and possible solution.

2. Pricing

The town of Ipswich established a seasonal water rate structure in 2003. The goal of the season rate structure is to manage summer water demand while remaining revenue neutral. With this structure, residential customers have their water rate increase 1.5 times the base (nonresidential) rate between May and November of each year. During the winter months, the rate drops below the base rate by a factor that is determined at the end of each summer. This rate drop is key to the revenue neutral portion of the structure. Residential customers with consistent annual usage pay no more each year than they would with the year-round base rate.

3. Outreach and Education

The Utilities Department sends a quarterly newsletter to all its customers, with the spring issue focusing on water conservation tips, the status of the system, and an announcement for the Annual Open House at the Water Treatment Plant. In recognition of Drinking Water Week, the Water Division increases its public awareness campaign with articles in the local newspaper. Personnel also conduct information sessions at the local elementary schools and host a poster contest.

4. Other

The town of Ipswich has developed a Water Bank. If there is a new housing development in the town with more than three houses, the developer has to search for its own water through offsets. The developer must also seek the town's approval in order to get water from Ipswich's water supply.

[92] Source: http://www.ipswichutilities.org/default.aspx?Page=WATER

Reading[93]

Since 2003, the town of Reading has been implementing a comprehensive water conservation program, which includes rebates, residential water audits, retrofits of municipal buildings with water-saving devices, an audit of the town's water distribution system, leak detection and repair, and an extensive public education program. As of 2011, the town had issued $434,780 in rebates to more than 1,000 households. In addition, nearly 3,000 water-saving retrofit devices had been distributed as part of free home and irrigation system water audits conducted for residential customers.

All municipal buildings have been retrofitted with water-saving fixtures, including toilets, showerheads, and faucets; the town also conducted a system-wide audit to evaluate potential ways to conserve water in the town's treatment and water distribution systems.

CONSERVATION EFFORTS

1. Leak Detection

The town conducts system-wide leak detection annually. It also conducts free home water audits that include both indoor and outdoor water use. The audit covers showerheads, faucet aerators and other fixtures, installation of free water-saving fixtures (such as shower heads, aerators, garden hose nozzles, displacement bags for older model toilets), comparison of water use patterns, evaluation of outdoor water use, leak checking, a report with recommendations, and free educational material.

2. Pricing

Reading obtains water from the Massachusetts Water Resources Authority. As of September 2011, quarterly water rates are $8.27 per hundred cubic foot, with a minimum bill of $16.54 per quarter.

3. Residential Rebates

The town, as part of its water conservation rebate program, offers cash incentives to residents for purchasing water-efficient appliances and fixtures. All rebate applications must include as proof of purchase: an original, unaltered and dated sales receipt with brand and model number on the receipt. Rebates are available for the following items:

- High-Efficiency Clothes Washers - $200 per washer.
- Low-Flush Toilet (1.6 gallons per flush maximum). Rebates are available for purchases, permits, and installation costs, up to $120 per toilet. Toilets must replace a non-water saving toilet (3.5 or more gallons per flush) to be eligible for a rebate. Toilets purchased and installed in new construction projects or room additions do not qualify for a rebate. Also, replacing an existing low-flush model with another does not qualify for the rebate.
- Moisture sensor for irrigation system - up to $25 per sensor.
- Rain Barrel - $25 per Great American Rain Barrel.

4. Outdoor Watering

The town has restrictions on outdoor water use. The town has an odd/even-day watering restriction and the hours for water use are Monday through Sunday from 4:00 a.m. to 9:00 a.m. and 5:00 p.m. to 8:00 p.m.

5. Outreach and Education

The town also conducted an outreach and public education campaign on the water conservation and the rebate program. The outreach program included a water conservation curriculum delivered to all third-grade classes in the town. Approximately 370 students learned about water conservation and brought home an information packet and sample devices.

---

[93] Sources: http://www.ci.reading.ma.us/dpw/; http://www.mass.gov/dcr/watersupply/ipswichriver/demo7-retrofits.htm, and Interbasin Transfer Required Annual Report dated July 28, 2011, from the Town of Reading to the Department of Conservation and Recreation.

Sharon[94]

The town of Sharon consumes approximately 1.2-1.5 mgd during the winter. Over the summer, especially in July and August, this number goes up to 2.5 mgd. Over time, use has dropped in Town, but the Town has found that the consumption of water is proportionate to the level of income.

CONSERVATION EFFORTS

The town of Sharon received a Water Conservation Award from the commonwealth of Massachusetts in 2009 and 2010. The town has focused on imposing heavy restrictions on lawn watering, which accounts for a significant percentage of the water consumed. Through water conservation, the Town is striving to ensure that its reservoirs don't dry up during the summer months. The town of Sharon has numerous conservation initiatives.

1. Leaks

Residences consuming more than 100,000 gallons per month are offered free audits, conducted by Energy New England. The audits provide customers with customized analyses, highlighting the most cost-effective strategies for conserving water. These audits would be key to finding leaks in people's homes, significantly reducing people's bills. The town provides the following tips for preventing leaks,

- Write down the reading on your water meter before leaving home. Check it again when you return. If it advanced while no one was home, there must be a leak.
- Worn out toilet flappers are a common source of leaks. You can check your toilet for leaks by putting food coloring in the tank and waiting a few minutes to see if the color leaks down to the bowl. (Note: if you have to jiggle the handle of your toilet to prevent it from running, fix it promptly.)
- If you have an irrigation system, be sure to winterize it properly, and check for leaks as soon as the ground thaws in spring. Be sure the nozzles are not leaking and are aimed at the lawn, not the sidewalk.
- Check faucets in the kitchen, bathrooms and outdoors, as well as showerheads. If you know there's a leak but can't find it, call the Sharon Water Department for help.

2. Pricing

Sharon has an increasing-block and seasonal residential rate structure:

Water usage, quarterly (gallons)	Winter Rate (Oct. – Mar.) (per 1,000 gal.)	Summer Rate (Apr. – Sept.) (per 1,000 gal.)
Base Fee	$15.00	$15.00
0 – 7,500	$3.00	$4.00
7,500 – 15,000	$6.00	$7.00
15,000 – 22,500	$8.00	$9.00
Over 22,500	$12.00	$13.50

Rates effective January 1, 2012

3. Residential Rebates

The town offers rebates as cash incentives to residents to improve water efficiency:

- A rebate up to $200 with the purchase and installation of a high-efficiency toilet (toilets that use less than 1.28 gallons per flush or less).
- A rebate up to $200 for high-efficiency washing machines with an EnergyStar Water Factor of 6.0 or less. The Town of Sharon provides 50-60 rebates a year.
- A rebate of up to $200 for purchase and installation of climate based irrigation controllers tested under the Irrigation Association's Smart Water Application Technologies Program (SWAT).
- A $300 rebate to decommission existing underground automatic irrigation systems with the capacity to irrigate 5,000 square feet or more.

[94] Source: http://www.townofsharon.net/Public_Documents/SharonMA_DPW/water

- A rebate of up to $200 to perform an audit of in-ground, automated irrigation systems; audits must be done by a WaterSense-certified irrigation partner.
- Rain barrels available for purchase for $50.

4. Outdoor Watering

From May 1 to October 1, the residents of Sharon are allowed to water their lawns on the schedule outlined below. One hand-held hose is allowed per premise with no restrictions.

- **Odd numbered** houses can water lawns on Monday and Wednesday from 6:00 pm to 8:00 pm.
- **Even numbered** houses can water lawns on Tuesday and Thursday from 6:00 pm to 8:00 pm.
- Exemptions are granted for new lawns for a period of two weeks.
- **No watering** is allowed on Friday, Saturday, or Sunday.

The Sharon Water Department prefers that customers minimize or eliminate the need for lawn irrigation by cultivating drought tolerant grass varieties, establishing a deep layer of organic loam, and allowing lawns to go dormant during periods of drought. For customers who do irrigate, the town offers the rebates described above to help residents with automatic sprinkler systems to irrigate as efficiently as possible.

Wayland[95]

The Town of Wayland, through its Board of Public Works, may declare a state of water supply conservation upon a determination by a majority vote of the Board that a shortage of water exists and conservation measures are appropriate to ensure an adequate supply of water to all water consumers.

CONSERVATION EFFORTS

1. Pricing

The Town of Wayland operates with an increasing block rate pricing system with four tiers.

Residential Water Users

Water Usage, cubic feet	Residential Rate (per 100 cubic feet)
<1,500	$5.10
1,501 – 3,000	$6.60
3,001 – 8,000	$7.75
8,000+	$12.50

2. Outdoor Watering

The town of Wayland requests residents to limit outdoor watering to two days per week. In addition, a restriction on outdoor watering can include one or more of the following elements:

- Outdoor watering is permitted only during daily periods of low demand, to be specified in the declaration of a state of water supply conservation and public notice thereof. Currently the town has an odd/even day watering restriction between the hours of 7:00 pm and 7:00 am. Hand-held hose watering is not restricted.
- Hand-held watering only.
- Outdoor watering is prohibited.
- Filling of swimming pools is prohibited.

[95] Source: http://www.wayland.ma.us/pages/WaylandMA_Water/index

~~*Deval Patrick*~~
Charles D. Baker
Governor

~~*Timothy P. Murray*~~
Karyn E. Polito
Lt. Governor

~~*Richard K. Sullivan, Jr.*~~
Matthew A. Beaton
Secretary

Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
Boston, MA 02114

(617) 626-1000
http://www.mass.gov/eea/

Follow EEA Secretary ~~Sullivan~~ on Twitter: twitter.com/massEEA

Visit The Great Outdoors blog: www.mass.gov/blog/environment

~~Visit the Energy Smarts blog: www.mass.gov/blog/energy~~

Visit the Energy Smarts blog: https://blog.mass.gov/energy/

View videos on You Tube: www.youtube.com/MassEEA

View downloadable photographs on Flickr: www.flickr.com/photos/masseea/sets/